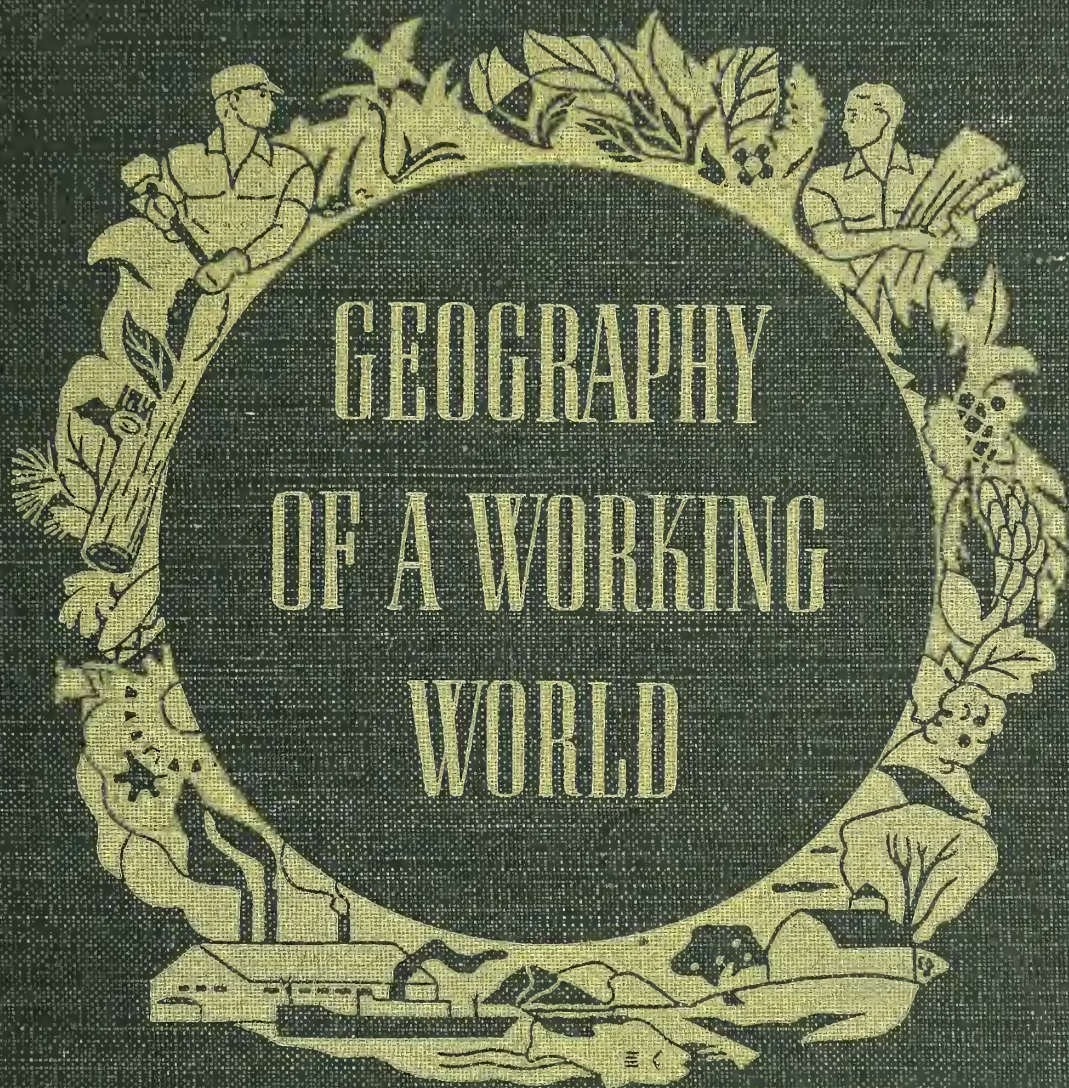


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RAND McNALLY SOCIAL STUDIES SERIES

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GEOGRAPHY OF



RAND McNALLY & COMPANY

A WORKING WORLD

WALLACE R. McCONNELL and HELEN HARTER

Art Cartography by VALDEMAR PAULSEN

GEOGRAPHY OF A WORKING WORLD ★ A Book of the Rand McNally Social Studies Series

New York

★

CHICAGO

★

San Francisco

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To the Teacher

Viewpoint. Our world of today is a new kind of world. It is not just a rearrangement of things that have always existed. There are new things in the world—things never dreamed of a few hundred years ago. Men have learned about more and more materials that can be used to change and improve ways of living. They have learned new techniques for obtaining these materials and for putting them to work. They have learned how to use the materials of the earth to make other materials. They have learned to increase the quality and usefulness of the materials of the earth, by processing them and by using them in new combinations. Along with these advances in the procurement and use of materials have come high-speed communication and transportation. Our world is one world now, in which working together is as important as work itself. With great changes in technology and physical environment have come changes in the relations between people and nations. The work of the world has drawn all people closer together. In this new relation, all peoples must work together for common desirable ends. Awareness of this basic fact in the world is a primary requisite for intelligent citizenship. Understanding of the world, its people, and the work they do is basic to this awareness.

Like all the texts of the Rand McNally Social Studies Series, this book has one major theme. In this book it is the relationship between natural resources, the activities they support, and population patterns on the earth. The book is built on the assumption that the pupil has a background of knowledge about the earth and its people. Its purpose is not so much to provide new information about the earth as to establish new understandings about relations between men and the earth. These understandings come by way of concrete examples, which are fuller and more detailed accounts of things the pupil has already learned in part, presented here with a new direction and purpose.

Since the purpose of this book is to contribute to the growth of intelligent citizens, the authors seek to develop real understanding of some of the human problems of our time—problems of overpopulation, conservation, wise use of resources, cultural differences in the use of resources, and the social effect of such differences. Through the discussion of these cultural differences and some of the reasons for them, it provides a background for a sympathetic understanding of all peoples, including those who are usually dismissed as backward and wrongheaded.

The distribution of material resources upon the earth is emphasized, but only that another distribution may be better understood—the distribution of people and their activities.

Every chapter in this book begins with the pupil where he is, here and now. Every chapter ends with the world and world understandings. But the pupil himself is brought into the picture at the beginning and remains there to the end. He has a stake in all that goes on in the world. It is the job of this book as of all social-studies education to make him aware of this fact.

Content and Organization. *Geography of a Working World* is a text in occupational geography. It presents from the geographic standpoint the work done by people in various parts of the world and provides sufficient background for understanding the historic development of their occupations. This book is not simply a collection of statistical data on exports, imports, and general trade information. It does include statistical data in abundance—maps, graphs, tables, and other useful tools. But these data are used as tools for understanding how people live and work.

Gradation. To repeat a statement made above, “Every chapter in this book begins with the pupil where he is, here and now.” This statement represents a characteristic of the Rand McNally Social Studies Series. No new fact, no new idea, no new understanding is ever introduced for which the pupil has not been gradually and carefully prepared. This is gradation at its best. It is not a fixed and arbitrary gradation aimed at numerically defined grade levels. It is a developmental gradation based on pupil capacity and learning experience.

Objectives. The goal of education in the social studies is the making of intelligent citizens, adequately equipped to live creatively in our world of working relations. Toward the eventual attainment of this goal, *Geography of a Working World* has been planned to provide the materials for developing the following understandings:

1. Everything we have comes from the earth, and work transforms the earth’s raw materials into usable products.
2. The earth’s raw materials are not evenly distributed.
3. The resources of the world include work, invention, organization, technology—things which are not material, as are coal and iron.

4. No one explanation of development can be applied to the whole earth.
5. Modern industrial civilization is utterly dependent upon the use of power.
6. Only industrialization will support a dense population at a high level of living.
7. Transportation and communication widen the effective environment of every individual.
8. The distribution and condition of populations depend upon the distribution of natural resources and the uses that are made of them.
9. The need for materials and for working equipment and techniques is a need common to all peoples.
10. The stability of our world depends upon access to materials and techniques commensurate with increasing the standards of living of all peoples.

Maps. The map equipment in *Geography of a Working World* is unique. It is unique in quality—of the maps as maps, and of the maps as visual portrayals of the world, its resources, and its interrelationships. Included are maps based on the geographic factors essential to understanding the various cultures of the world in relation to the kinds of work people do.

Growth in the power to use maps efficiently should progress gradually. The first book in this series of geographies presents no maps at all, but much time is devoted to making the things later to be symbolized on maps concrete, real, and familiar. In the next book of the series very simple perspective globe pictures are used to present the map idea. Near the end of that book the pupil is given a very simple yet very thorough introduction to the use of colored maps. In the third book of the series conventional maps are used throughout, but each map is presented separately in immediate relation to pertinent subject matter. In the fourth book of the series, colored maps of specific areas are presented. All general reference maps are grouped for easy access.

In *Geography of a Working World* all maps for general reference are presented in color in an Atlas section at the end of the book. In this Atlas section a new kind of population map is introduced. These new maps present the population patterns in the United States in a way that brings out their relation to occupations and resources. The unusual features of these maps are the following:

1. Separation of rural and urban populations. This is much more significant than mere overall density of population for showing the relationships between distribution of population and human occupations. Unfortunately, statistics are not available for making comparable maps of the world.
2. All cities of more than 10,000 population are shown, thus bringing out the complete rural-urban population pattern.
3. All cities of more than 50,000 population are shown with their metropolitan districts. It is the concentration of population in an urban area that has social significance—not the location or extent of cities as political entities. In this respect, the maps follow a procedure begun by the Bureau of the Census in 1930.
4. Actual areas of metropolitan districts are shown. Especially noteworthy are the differences in the extent of urbanized areas in different regions.
5. Historical maps show the changes in population patterns that result from (1) spread of settlement and (2) industrialization.
6. By showing railroads, the maps suggest the relations between changing population patterns and transportation routes.

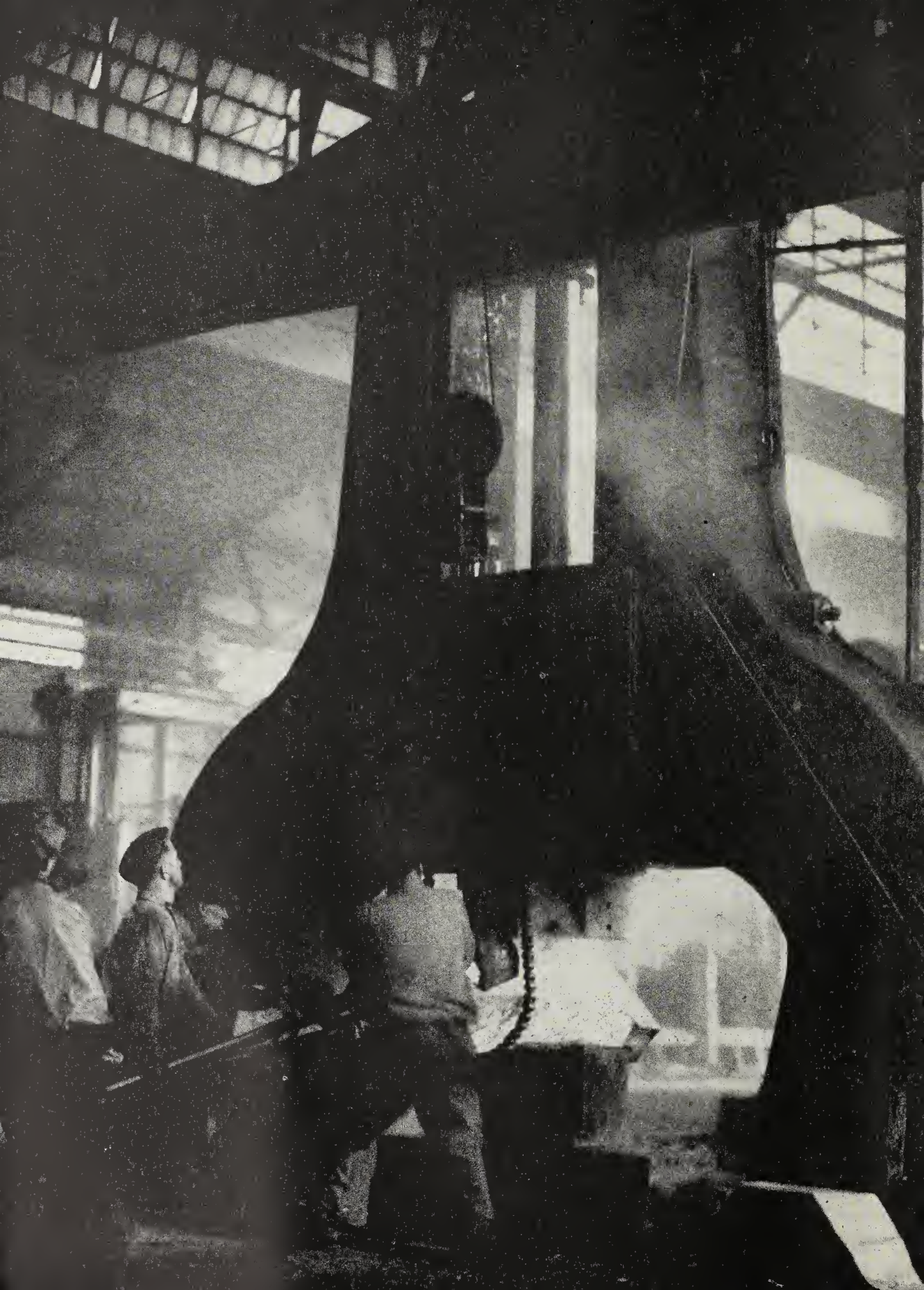
The method employed is to present problems in such a way that the pupil will refer to his Atlas section and select from any or all maps found there such information as is pertinent to his problem. Both in map equipment and in the uses made of it, the program is one of gradual development.

Workshops. The Workshop at the end of each chapter puts the understandings in the chapter to work. Hence the name "Workshop." The exercises in every Workshop are functional. Their varying character and the great number of them make possible adequate provision for individual differences. They lead the pupil into purposeful activity using the learnings that are being acquired. "What important learning purpose is served by this exercise or this activity?" This question has guided the planning of every Workshop.

The development of critical thinking. In the preceding texts of this series, the peoples and lands of the world have been presented for study. Simple but fundamental understandings regarding their relationships have been presented. In this text the pupil is encouraged to engage in simple forms of research. He is given opportunity to begin the kind of reasoning and investigative procedure that adults find useful. He is introduced to the simpler forms of interpretative graph and is encouraged to make his own interpretations through graphic procedure. He is given an Atlas section of maps of general reference character, and is provided opportunity to use them in deriving simple, useful conclusions through comparing data secured from different maps. He is asked to use these assembled data to reason through a situation to a tenable conclusion. In short, he is encouraged to continue the development of a capacity for critical thinking, without which effective citizenship is impossible.

With the world closely knit together by the advance of technology, every country has an inescapable obligation to be intelligent about its newly found neighbors. Without any definite intention to build a world like this, we suddenly find ourselves living on each other's doorsteps. We do not have to approve everything our neighbors do, but we face the necessity of living close together in the same world with them; and if we remain ignorant about them—how they think and live and what social and cultural purposes motivate them—the distrust and suspicion which ignorance always creates will in the end lead to new catastrophes. No intelligent man can ever again say about any political event or social process in any part of the world: "This is nothing that need interest me."

RAYMOND B. FOSDICK
President, Rockefeller Foundation





This Is a Working World

MATERIALS FROM THE EARTH PLUS WORK

Everything we have comes from the earth. Even this book in your hand came from the earth. Not the book itself, with its pages and ink and cover, but the materials for it. Work was added to the materials. Materials from the earth plus work produced your book and everything else.

This book is printed on paper. Paper is made from wood pulp. Wood pulp is made from trees. Trees grow in the earth, and they build their trunks of substances drawn from the earth. Some of a tree's building materials come from the air, but scientists call air part of the earth. Between the tree and the paper lies the work of many, many people—lumberjacks, truck drivers, train crews, and workers in a paper mill.

Paper alone does not make a book. There also must be ink. There are oil wells in the earth, but not inkwells. Printer's ink is

made of pigments, specially prepared oils, and rosin. The pigment in black ink is lampblack, a substance usually made by burning materials taken from coal tar. Coal tar comes from coal, and coal comes from the earth. With that much information, you can name some of the kinds of work that went into the making of the ink.

Now look at the maps at the back of this book. They are printed in colored inks. The pigments in those inks were dug from the earth. Then they were purified, ground, and mixed with other materials.

This book has a cloth cover. The cloth was woven from cotton fibers. The cotton plants grew in the earth. There is no substance in the fiber that was not drawn from the earth, but between the growing fiber and the cloth there are at least a dozen different kinds of work.

To make the heavy cardboard that stiffens the cover, many layers of paper were glued together. The glue was made from the horns and hoofs of cattle. The cattle grew by eating grass and grain that grew from the earth. How many kinds of work do you suppose were required to change those earth materials into the glue for your book?

The book was printed with type dug from the earth. No, that is not quite right. We do not dig type from the earth. From the earth miners dug the ores of zinc, antimony, and tin. Metal workers smelted the ores to get the metals. Other workers combined the metals in just the right quantities for type. Still others made the molds on which the letters were cast.

The difference between materials in the earth and your book is **WORK**. The work of many people contributed in some way to this book you are reading. Authors write a book, and printers print it. Some people think that is all there is to a book. You can see how wrong they are. Lumbermen, farmers, miners, train crews, ship crews, truck drivers,



Gregor from Monkmeier

The four people pictured on these two pages are among the



Philip Gendreau

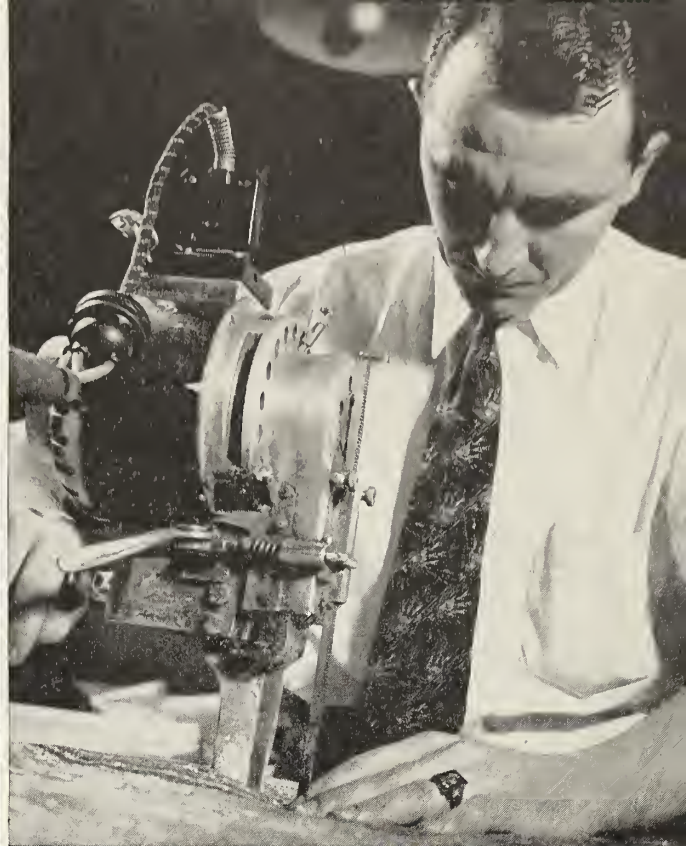
workers in dozens of factories, photographers who took the pictures, draftsmen who drew the maps, typists, binders—these are some of the people who make a book. Then there are farmers, fishermen, packing-house workers, and millers who fed the workers who made the book; farmers, textile-machine operators, tanners, and garment workers who clothed them; actors, baseball players, and musicians who amused them; doctors and dentists who kept them well.

Now whom have we left out? Hundreds and hundreds of people. You can make a long list of them for yourself. Try it. You will not even have to go back to the people who made the machines that made the machines that made the book, or to those who mined the ore that made the metal that went into the cotton gin that cleaned the cotton that went to the cotton mill that wove the cover cloth for the book.

Everything we have comes from the earth, but nothing except the air we breathe is any



Courtesy Milwaukee Journal, photo by Edward Farber



Meisel from Monkmeier

millions who help do the world's work by changing materials from the earth into things people can use and enjoy.

good to us without work. Work is what this book is about—work that gets materials from the earth and changes them into things that people can eat, wear, use for shelter, ride in, read, and enjoy.

Right at this moment thousands of people are working to produce things that you will use. A man stands in front of a machine in a shoe factory. He thrusts the back of an unfinished shoe into the machine. Bang! The machine hits the shoe. It flattens the leather and drives five nails. He tosses the shoe on a rack and reaches for another. Bang! All day long he has been doing this. You will wear a pair of shoes that have been on his rack.

In southern California a man stands with a hoe in his hand. He is opening a tiny channel so that irrigation water can flow along the earth between his orange trees. You will eat some of his oranges.

Out at the foot of the Rocky Mountains a lonely shepherd is watching his flock of

sheep. You will wear clothes made from the wool of his sheep.

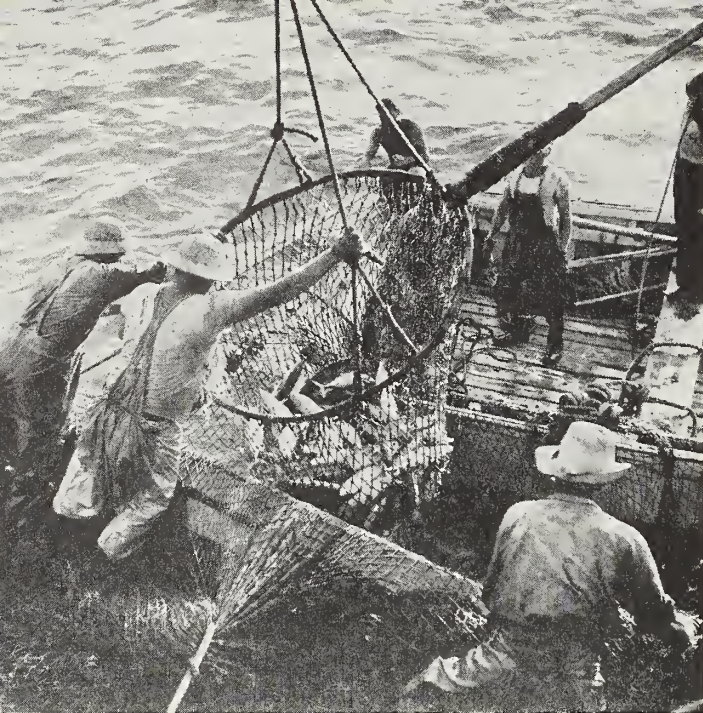
In a southern cotton mill a woman watches a long row of whirling spindles. You will dry your hands on a towel woven from some of the threads she spins.

On the wide plains of North Dakota a farmer is driving a truck to town. In the distance a tall grain elevator rises above the houses of the town. The truck is filled with wheat. You will get some of that wheat in your breakfast toast.

Somewhere a man places a lump of clay on a machine and shapes it into a plate. You will eat from a plate he makes.

In Texas a man sets up a pump over an oil well. Some day you will ride in an automobile driven by gasoline extracted from the oil pumped from that well.

Halfway around the world a dark-skinned man pulls the levers that control a huge dredge. The dredge is scooping tin ore from the bottom of a river in Java. Some



Courtesy Hizson-O'Donnell Advertising, Inc., Los Angeles

The fish we eat, the oil that provides gasoline for our automobiles—these and everything else we have come from the land or the water or the air.

Meisel from Monkmeyer



day you will eat soup that came in a can made in part from that tin.

In the engine room of a ship a man adjusts the flame of an oil burner. The oil heats the water that makes steam to run the engine that moves the ship. The ship is carrying bananas that you will eat.

High in a tall building in New York a man sits at a desk. He is writing a play for a radio program. You will listen to that play when it goes on the air.

At the edge of a pond a man is sawing logs into short lengths. His power saw eats into the logs with a sound like the song of a gigantic mosquito. The wood will be made into pulp, and the pulp into paper. You will read a book printed on the paper.

In a factory a man is watching a machine that grinds roasted cacao beans. You will eat some of those cacao beans in the form of a chocolate bar.

High above the busy, noisy floor of a steel rolling mill the operator of a traveling crane pulls levers and pushes buttons. Dangling from the end of a long cable is a bundle of steel ingots. Some day you will ride over those ingots in a train, after they have been rolled into rails and spiked to the ties of a railroad track.

Somewhere an architect bends over a drawing board. He is drawing the plans for a new building. You will walk through the door of that building.

Somewhere a man is picking up a brass tube that has just been formed in his machine. The tube will become part of a trombone. You will hear a musician in a band play it over the radio.

A man sits before a thumping punch press. At every thump the press shapes a piece of aluminum. The aluminum will become part of a car that you will ride in some day.

This could go on and on and on. You eat food, wear clothes, travel from place to place, walk into buildings, and listen to the radio. Someone has to plan all the things you use. Someone has to grow or make them. Someone has to bring them to you.

Many people are working now on things you will use next week and next year and even when you are a grown man or woman.

You need not go far from your home to find people handling products that you will use. If you live in the city, a milkman probably brings milk to your door. The postman brings your letters. Telephone operators put through your calls. Clerks in stores sell you clothes, pencils, groceries, ice-cream cones, candy, and sports equipment. At home someone prepares your meals and keeps the house clean.

Your community is full of people working. If you look through the window right now, you will probably see people working. You don't even have to look through the window to see one person working. Who is it?

While you study this working world, you can use your own community as a laboratory. Nearly everyone has some kind of work to do. Start your study with a list of the kinds of work people do in your community. You will probably find it worth your while to spend several days doing this before you go on with the study of this chapter. But don't think it is finished and put it aside. You

will be going on with the study as long as you use this book.

Turn to the Table of Contents and examine it carefully. It will help you to classify the workers in your own community. Each chapter heading stands for a whole group of occupations, not just one.

After you have sorted people into all the classes named in the chapter headings, you will still have some left over. Your teacher is one example. There are also doctors, lawyers, policemen, officials, and many others who are not included. You can pick out others from the paragraph on page 4. They do not produce anything that you can see or hear or feel, but they are very necessary. They belong to the service industries. You will need this classification in sorting out the workers of your community.

Look also at the Workshop, beginning on page 21. The Workshop is a guide to what is most important in the chapter. It will help you to know what to look for in your community. It will tell you what new words you are expected to learn and remember so that you can use them yourself. It is meant to be a guide for your study.

WORKERS AND RESOURCES

Did you ever stop to think why nearly everyone works? You may say that people work to make money; but there is a better answer. They work so that they may have something to eat, clothes to wear, a house to live in, a car to drive; they work to make their surroundings pleasant and to have a chance to enjoy themselves. Forget the money for the present. Money is only a convenient way of expressing value. Think of a day's work as having the value of a week's supply of groceries, or a new pair of shoes, or a trip to visit relatives, or twenty moving pictures, or a new dress for the worker's little girl. Perhaps a hundred days' work are worth an automobile. Three or four days' work may be worth a month's rent.

The worker cannot very well work one day a week for the grocer, a day now and then for the owner of the theater, a few days each month for the landlord, a day for the railroad company, and several months every few years for an automobile manufacturer. Instead he works to produce something that other people want. He takes his pay in money. Other people will provide goods and services for some of his money.

People really work to turn the natural resources of the earth into something useful. Natural resources, you know, are all the things provided by the earth that people can use. Work makes them useful. Coal is a natural resource, but it is not useful until it has been mined and taken to the people who



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A farmer's work has produced something useful from the fertile soil of a cornfield. Animals fattened on the grain he raises will provide food, clothing, and other things that people want.

need it. A fertile soil—a soil rich in plant foods—is a natural resource, but it is not valuable until plants have grown in it and those plants have been used.

How Pioneers Used Natural Resources

Today the work of many people goes into preparing natural resources for use. The workers have many different occupations, and many of them will never see or use the finished products they help to make. This has not always been true.

Few pioneers would have known the meaning of the words "natural resources." They were very much concerned about them, all the same. They thought about timber and game and springs. They thought about soil and rain, heat and cold. They thought about hills, valleys, and rivers.

Pioneer occupations. Imagine a family starting a new home in the forest. The father knows how to do a great many things. If he didn't, his family could not live here.

Perhaps he is not very skillful at any one thing, except maybe at shooting with a long rifle. He knows how to build houses, make furniture and farming tools, tan hides, salt and smoke meat, chop down trees, split rails for fences, whittle out wooden forks, spoons, and bowls. Everything he makes is rough and crude, but it will do. His family is used to make-shifts. He knows how to farm, but first he must get his land cleared. He is not an especially good farmer, but on his fertile, new land he can raise enough corn for the family corn bread and the family pig.

His wife can make almost anything, too. She does not usually chop, split, or whittle, but she can cut and sew buckskin for

clothes—or use cloth if she has any—make soap, raise vegetables in a garden, make hominy or meal from corn, bake in a frying pan, dry fruit, find wild plants that are good to eat, and, if necessary, shoot a bear or an Indian. If she is a very superior sort of pioneer woman, she may teach the children to read and write. Reading and writing are not considered very important. It is much more necessary that the children learn to provide for themselves everything they must have for living.

A pioneer and his wife, all by themselves, carried on most of the occupations you will read about in this book. They hunted, fished, farmed, and kept animals for food. They used the forest as a source of building material, fuel, and food. They even made medicine from plants. The pioneer was not exactly a miner, but he probably did get minerals from the earth—stones for the fire-place, salt from a salt lick. Pioneer men and women made almost all the manufactured articles their families had. Most pioneers did a little trading. Some of them carried furs back to the more settled regions

for sale. That called for transportation, usually on pack horses.

Looked at from a long way off, pioneer living in the forest seems free and delightful. You need to look twice to see how hard and uncomfortable it was. Pioneers had limited resources to use. No one small area has everything, but the pioneer had to get along with the resources that were within a few miles of his cabin. No one person has all kinds of ability. No one person has time in his whole life to learn how to do everything well. Pioneers had to provide everything for themselves or do without. They did without many things, but food, clothing, and shelter they could not do without. They had to provide these things, out of the materials near them, by the use of such skills as they had.

Resources attracted settlers. Those first pioneers went out beyond the frontier to live. As the term is used in American history, the frontier was the outermost edge of settled land. Just what is settled land? Clearly, when one or two pioneer families have moved into an area of several hundred square miles, we cannot call the land settled. Just as clearly it is settled when most of the land is in farms, one after another, with towns scattered over the country every few miles. But to talk clearly about settled land, we must have a more exact measure. Even more, we must have an exact measure if we want to show on a map how settlement advanced across the country. Historians have generally agreed to consider an area settled when it has an average population of at least two people to the square mile.

Settlement spread rapidly in America. Real pioneer living did not last long in any one place. If a region was good for farming, more people came within a few years. They might still live in log cabins at first, but the cabins were better made. All the people of the community helped when a new one was to be built. As soon as real communities grew up, people began to specialize in their

work. Someone set up a sawmill. From then on new houses were made of boards, not logs. Someone built a gristmill, where the farmers could take their grain for grinding. Roads were opened up and trade began. Someone started a general store. Even a very new and small community had a school-teacher and a minister.

Settlers considered the natural resources carefully before they moved into a region. You have heard the story of Daniel Boone. When he was trying to persuade settlers to go to Kentucky, he talked about the fine forests, the game, the fertile soil, the good climate. Then there was another resource that he did not mention. That was Cumberland Gap, a famous pass through the Appalachian Mountains. The fairly easy transportation route through this pass was one of the reasons why the first settlement west of the mountains was in Kentucky.

People moved into regions where they thought they could find useful resources. In most of North America, the first settlers were attracted by resources useful to farmers. This was not always true, especially in regions that were settled late. The resource might be gold, copper ore, a good harbor, or one of many others.

In general, the more abundant the resources that people could use, the more the population grew. Some regions are richer in resources than others. Some regions have resources that will support a dense population. Other regions will support only a few people. In such places the population has remained sparse to this day.

People must also know how to use resources. Pioneers left many resources unused because they did not know how to use them or did not have the right tools for using them, or because the resources would be useful only after they had been carried somewhere else. In general, though, the richer the resources of a region, the denser the population. Since this is true, you can use a population map as a clue to the abundance of natural resources in a region.

Reading Population Maps

Turn to the colored maps, beginning on page 362, at the back of this book. In this Atlas section you will find the maps that you need to use over and over again. They have all been put where you can find them easily. Use them often. Maps are the most useful of all geographic tools.

Look at the map on pages 374-375. This is a population map of a kind you have never used before. It shows the population as it is today. Read the key carefully. The map shows all cities of more than 10,000 population. Difference in size is indicated by shades of red and purple. Shades of green show density of rural and small-town population. Don't try to understand everything on the map right now. You will learn more about it by using it.

Population distribution. You notice at once that the colors seem to form patterns on the map. We call them *population patterns*. Nothing stands out more clearly on the map than the small region of very dense population in the northeastern part of the United States. A large part of the area is occupied by cities. Outside the cities, the rural and small-town population is very dense.

From the small area of very dense population, streamers extend westward. There are not so many very large cities, but the map is peppered with cities in the 10,000 to 50,000 class. In some places on the map there are curious rows of cities. By this time, if you have any geographic curiosity, you are beginning to wonder why.

The South has a very different population pattern from the North. There are fewer cities. Cities are more evenly distributed than in the North. In some parts of the South the rural and small-town population is quite dense. In other parts the population is very sparse. Again, why?

From eastern Texas you can trace a curved line of large cities northward to Lake Superior. A line of smaller cities curves

northward from New Mexico to Montana. East of these cities lies a region of very few people. Are there reasons for these curious population patterns?

You can find dozens of such problems by studying the map. Suppose we select a few and try to answer them now. You will find others answered later and will learn to answer some for yourself.

Value of a good location. From what you know of American geography and history you can think of reasons behind the population pattern in some places. That is, you can think of probable reasons. Explanations are usually not so simple as you think. Unless you know a region thoroughly, your ideas will be only guesses. At best they will be incomplete. The following example will show you how wrong a guess can be.

The densely populated region near the eastern coast covers about 30,000 square miles. It has about 24,500,000 people. Now look at the area of very sparse population from western Utah to eastern California. There it is possible to pick out an area of 30,000 square miles that has less than 10,000 people. Thus in the United States there are two areas of the same size, one of which has 2450 times as many people as the other! The area in the East averages more than 800 people to the square mile. In the western area, there is an average of one person to every three square miles. Do you suppose the maps show the reason for this great difference in population?

The physical-political map, pages 378-379, shows that most of the eastern area is less than 500 feet above the sea. Most of the western area has an elevation of more than 5000 feet. In other words, the western area is at least ten times as high. Try the rainfall map, pages 364-365. More than 40 inches in the East, less than 10 inches in the West. Natural vegetation? Forest in the East, mostly desert vegetation in the West.

All this should be enough to account for everything, should it not? People can farm

in the eastern area; the western area is too high and dry for farming. The answer is easy and obvious. That last word means that it is so plain that anyone can see it at a glance. The only trouble is that it is only partly true. These differences do not account entirely for the difference in population. There must be something more.

Put the problem another way. In the eastern area almost one-fifth of the people of the United States live on one-hundredth of the land. Another one-hundredth of the land in the West has only about one fourteen-thousandth of the population. Good conditions for farming do not account for such a difference as that. Many parts of North America are good farming regions, but only one has this extremely dense population. We shall have to try again.

One difference is very plain—so plain that you may never have thought of it. The two regions are not in the same place. Does that seem a silly thing to say? Of course two regions are not in the same place! Maybe you have never thought of it, but location can be a very important natural resource. Where is the drugstore in which you buy soap, toothbrushes, and ice cream? The chances are that it is on a corner. Most drugstores are. A corner is a very good location for a drugstore because people can reach it easily along two streets. The busier the streets, the better the location. Out in the country, why is a gasoline station so often located where two busy highways cross? Someone picked out that place because he thought it was a good location for a gasoline station. Many people who may need to buy gasoline will pass it.

The corner drugstore and the crossroads gasoline station are in good locations for trade. They can be reached easily over streets and highways. Now suppose we give the streets and highways a more imposing name. Call them transportation routes. The drugstore and gas station can be reached easily over busy transportation routes. So can the crowded region of the East.

Great cities. All through its history, the eastern coast has had an advantage just by being the eastern coast. Its location—its position on the earth—has been a valuable resource. When groups of colonists first came to America from Europe, they naturally landed and founded settlements on the eastern coast.

In every colony—Spanish, French, English, or Dutch—the first settlements were seaports. Location was the very first natural resource used by the colonists. They had to keep in touch with their homelands, and so they needed harbors. Throughout colonial times the only cities were seaports. Boston, New York, Philadelphia, Baltimore, Charleston, and Savannah were really only small towns, but the colonists thought of them as important cities because they were the largest cities in the colonies.

Today the whole United States has just five cities with more than a million people each. Two of them are the old colonial cities of New York and Philadelphia. (The others are Detroit, Chicago, and Los Angeles.) New York alone has more people than there were in the whole United States at the time of the 1790 census. The United States has fourteen cities with more than half a million people each. Five of them are in the area of dense population that extends from a little north of Boston to Washington. Besides these very large ones, there are many cities with more than 10,000 people. You remember that this region is one-hundredth, or 1 percent, of the area of the United States. About 18 percent of the total population of the country lives here on 1 percent of the land.

Metropolitan districts. The sizes of these great cities do not tell the whole story. The map on pages 374–375 shows *metropolitan districts*. This term calls for a little explanation. You know, of course, that a district is an area, usually a fairly small area. A metropolis is a great city. The word was used first by the ancient Greeks. They made it up from



Dramatic night view of a great metropolitan area in southern California. Each point of brightness, like a symbol

two words, their word for “mother” and their word for “city.” To them a metropolis—mother city—was a city that sent out people to found colonies. The people who lived in each colony felt close ties with their metropolis.

When we speak of a metropolis we do not mean a city that sends out colonies, but the word still fits. We usually mean a city that has many suburbs clustered around it. Nearly all great cities are surrounded by smaller cities and towns. They have their own names and their own city governments, but in every other way they are part of the great metropolis. Then there are the so-called *urbanized areas*. Every city has them. They are outside the city limits, but they are not country. People live close together. They work in the city. They go to the city for shopping and for amusement.

The metropolis, its suburbs, and the surrounding urbanized areas make up a metropolitan district. For studying the work done in a region, a metropolitan district means more than a single city. Thousands of the

people who work in a city live in the suburbs. Many industries have their factories in smaller cities near by. The industries of a whole metropolitan district are usually related, too. The entire area may use the same railroads and ports, get raw materials from the same sources, sell in the same markets. Because its industries are related, they often need workers with the same skills. For example, in a shoemaking district, a shoe manufacturer can find many workers skilled in using shoemaking machines, and a worker looking for a job has a choice of many factories.

Now apply some of these facts to the densely populated region of the East. Take New York, for example. Turn to the map at the top of page 376. This map shows the density of population in the United States in 1790. Even then the region on the Atlantic coast had the densest population. Look at the cities on this map. The map shows cities of more than 10,000 people. Count them. In 1790 there were only five such cities in the whole United States. The largest city in



Keystone View Co.

on a population map, stands for many people.

the country was New York, with about 33,000 people. You might be interested in a table showing the population of all five cities in 1790. Here it is:

New York	33,131
Philadelphia	28,522
Boston	18,038
Charleston (S.C.)	16,359
Baltimore	13,503

All but Charleston are in the present region of dense population. Now look at the later population maps to see how the number of cities increased. The next map shows the United States in 1840. By 1840 there were thirty cities with more than 10,000 people. Half of the thirty cities were in the area of dense population.

The 1840 population map shows how transportation routes affect population density. In 1840 waterways were still the most important means of transportation. Of the thirty cities, twenty-seven were on navigable waterways. New York, Philadelphia, Brooklyn (now a part of New York), Boston, Balti-

more, New Orleans, Newark, Providence, New Haven, Charleston, Savannah, New Bedford, Portland, Norfolk, Mobile, and Salem were all seaports. Albany, Trenton, and Richmond were on rivers, but could be reached by ocean ships. Cincinnati, Pittsburgh, Washington, Louisville, and St. Louis were river ports. Troy, Utica, and Buffalo were on the Erie Canal. Only three of the cities in the list of thirty were not on navigable waterways.

Look at the railroads on the 1840 map. Railroads with steam locomotives to pull the trains were only ten years old in 1840. When you think of this, the miles of railroad are surprising. Just by looking at the map you can guess why most of the early railroads were built. They were built to bring goods to port cities. By 1840 each of the important ports had at least one line leading back into the country. The 1870 map shows many cities with more than 10,000 people. The 1890 map is thickly peppered with such cities. They are scattered still more thickly over the map of the United States at the present time.

On every map there are more cities in the densely populated region of the East than anywhere else. You have seen two reasons. First, this was the earliest area to be settled. Second, it is located along the Atlantic coast, with its ports facing toward the great trading countries of Europe. Some of the harbors are extremely good ones.

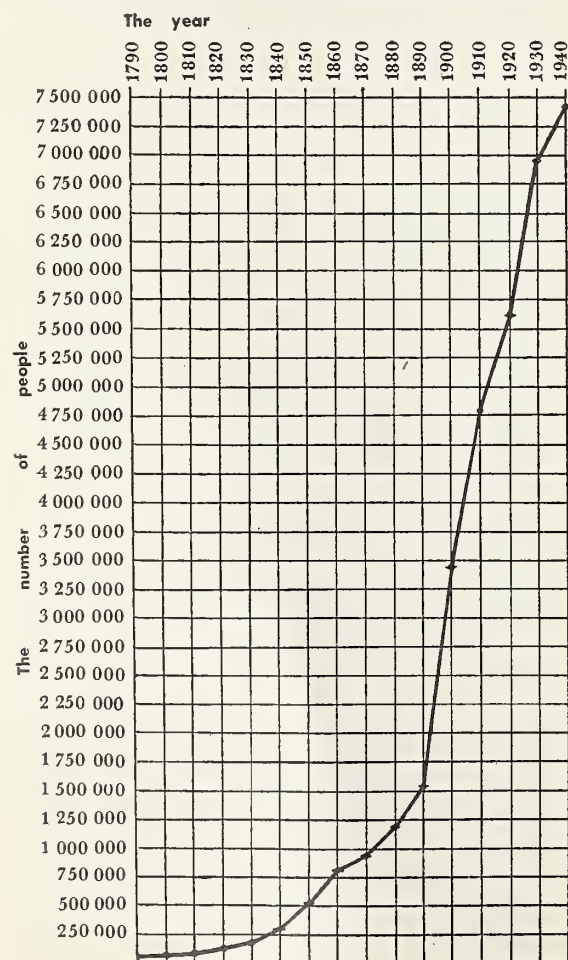
The Atlantic coast was the region of earliest settlement in the United States and Canada. You probably know the story of how the eastern region was settled and then settlement spread to the westward across the continent—how settlers from Massachusetts founded settlements in Maine; how new colonies were founded south of Virginia; how the settlers moved up the river valleys, then filled in the land between; how settlers took more than a century and a half to fill the region between the coast and the Appalachian Mountains. You know how settlers began to spill over the mountains about the

time of the Revolutionary War, and how regions were occupied one after another until the whole land was settled.

The population maps on pages 374-377 indicate this spread of population, but they also show that the eastern region remained most densely populated. In other words, population increased there more rapidly than anywhere else. A *graph* is a good way of showing population growth.

A population graph. The graph on this page shows how New York grew between 1790 and 1940. The first United States census was taken in 1790. A *census* is a counting of all the population. Every ten years, beginning with 1790, the government

Graph showing growth of population in New York.



of the United States has counted all the people in the country. The census takers make a record for every man, woman, and child in the country.

The up-and-down lines in the graph stand for the years in which censuses were taken. The crosswise lines stand for numbers of people. If you have any trouble understanding the graph, get yourself some graph paper and make one. Graph paper is ruled in squares. If you make a graph, don't just copy the one in the book. Do exactly what the next paragraphs say.

The vertical (up-and-down) line at the left of the graph stands for the year 1790. The base line stands for 0 population. The line next above the base line stands for 250,000, or a quarter of a million, people. In 1790 New York had 33,131 people. That is about one-seventh of 250,000. A mark goes on the 1790 line one-seventh of the way from the base line to the next line, which stands for 250,000 people.

The next vertical line stands for the year 1800. In that year New York had 60,515 people. That is a little less than one-fourth of 250,000. A mark goes on the 1800 line one-fourth of the way from the base line to the 250,000 line. The following table gives the population of New York at each census.

1790	33,131
1800	60,515
1810	96,373
1820	123,706
1830	202,589
1840	312,710
1850	515,547
1860	813,669
1870	942,292
1880	1,206,299
1890	1,515,301
1900	3,437,202
1910	4,766,883
1920	5,620,048
1930	6,930,446
1940	7,454,995

By using the table, you can work out the place for a mark on each vertical line. When all the marks have been placed, draw

a line from one mark to the next. The graph is finished. There are many kinds of graphs, but this is a very useful one. Some graphs do not show the crosslines, but you must always imagine the lines are there. You will always use crosslined paper when you draw this kind of graph for yourself.

The intervals between lines might have stood for any number. A quarter of a million seemed a good number in this case. It was the smallest number that would keep the graph within a reasonable size.

Why the population grew. The line on the graph shows the growth of New York during a century and a half. In 1790 it is very close to the base line. Down to 1830 the growth of New York was very slow. After 1830 the line goes up more steeply. In other words, New York began to grow more rapidly. Why? Certainly one reason was the opening of the Erie Canal in 1825. This was the first easy route to the lands west of the Appalachian Mountains.

The lower map on page 376 shows the density of population in 1840. In the dense population through central New York and along the Great Lakes you see a result of the opening of the canal. People settled where they could use the canal for transportation. The goods they shipped reached the ocean at New York. These goods increased the importance of New York as a port. At the time no other Atlantic seaport had such an easy route to the interior.

The goods shipped to New York were not all exported. Some of them provided food for the growing population. People cannot live in cities unless they can get food. There can be no large cities unless (1) there are farmers who produce food that they do not need for themselves and (2) it is possible to transport food from the farms to the cities.

At first New York was a trading city. Nearly everyone who worked there had something to do with buying, selling, or shipping goods. Shipowners and sailors lived there. Merchants lived there who bought goods

from the farmers and shipped them out by sea, or bought imported goods and sent them in small quantities to thousands of communities. In the offices of shipowners and merchants were clerks who kept records. Men packed and unpacked goods, loaded and unloaded goods, stored them in warehouses, hauled them in wagons from boat to warehouse and from warehouse to boat. There were shipbuilders and ship outfitters. Then there were the storekeepers who sold groceries and hardware and cloth to all these men and their families.

Besides these people, there were doctors and lawyers, teachers and ministers. There were actors and musicians. There were laundry workers, servants, and gardeners. There were street cleaners, firemen, and policemen. There were all the people who had a part in governing the city.

New York always had a little manufacturing. Every city has. There are always people who make things for their neighbors to use. A little before the War between the States, manufacturing grew rapidly. New machines and new methods were invented. New York then became a manufacturing city as well as a trading city. Goods were unloaded at New York and moved from one kind of transportation to another. Why not change some of them into manufactured goods before reloading them? Manufactured goods are more valuable than raw materials. They are usually less bulky to ship. Why not send on flour instead of wheat, ready-made clothing instead of wool or cloth?

A great increase in manufactures began about the middle of the nineteenth century. It kept New York growing from about 1850 on. Thousands upon thousands of young people left the farms and went to cities to work. New York attracted more of them than any other city.

Then there were the *immigrants*. Immigrants are people who move to one country from another. Often we talk about early settlers coming to America, but we seem to

forget that people kept on coming after the land was settled. At first only a few thousand came each year; then more and more came. They heard that America was becoming a great manufacturing country, and they believed that there was work at high wages for everyone who came.

By far the greatest number of immigrants landed in New York. A few had made plans to go to other parts of the country, but most of them were glad to work in the city. No matter where they came from, they found in New York whole communities of people who spoke their language. Among such people they felt at home. In the 1880's there was a great increase in immigration. Each year immigrants came by the hundreds of thousands. This went on until the 1920's. You can see the results in the population graph.

Notice how the line shoots up between 1890 and 1900. In that decade (a period of ten years) there was a special reason for the increase in population. New York City took in some of the densely populated areas around it. The area now called the Bronx, north of Manhattan Island, was taken in. So were Brooklyn and other towns on Long Island and the borough of Richmond on Staten Island.

Now turn to the graph on page 361. It shows the line for New York and lines for all the other cities in the United States that now have more than a million people. Philadelphia is the only other one in this densely populated eastern region. It is a great city, but it is not nearly so large as New York. It grew for the same reasons New York grew, but the reasons were less strong in the case of Philadelphia. Far fewer immigrants landed there. It does not have such an easy route westward. Look at the railroads on the 1840 map on page 376. One extends westward from Philadelphia. It was completed to Chicago in the 1850's. You can see what happened to the population of Philadelphia in that decade.

The reasons for growth do not apply to New York and Philadelphia alone. They

explain in part the growth of the many smaller cities in the region and of the region as a whole.

Interpreting the population map. Now turn again to the map on pages 374-375. Find an area of fairly dense population and many small cities in the southern Appalachian region. Find the same area on the historical population maps on pages 376-377. You can see that population has not always been dense in this region. Maybe you can think of a reason for the growth, from your own study of geography.

Do you remember reading about the new industrial regions of the South? Here, in the southern Appalachian valleys and on the Piedmont, many streams have been dammed to produce hydroelectric power. The power is used to work the spindles and looms of cotton mills, the saws and lathes of furniture factories.

Now look down at the southern tip of Florida. There you see an area of very sparse population. A glance through the historical maps shows that this was one of the last areas in the United States to be settled. Why? Why are there today far more people on the eastern side of the peninsula than on the western?

Look at the map on pages 378-379. Do you see those swamp symbols in southern Florida? Almost the whole southern end of the peninsula was once swamp. Those lines on the map that stand for canals show what has happened to part of the swamp. They are drainage canals. The canals have turned part of the swamp into good farm land. The western part of the swamp has not yet been drained, but some day it will be.

Why do most of the people in Canada live in the southern part? You can answer that one for yourself. Look at the latitude and the growing-season map.

Do you see one small area of denser population, northeast of Lake Huron? In that area there are rich deposits of nickel, silver, cobalt, and ores of other metals. These

valuable mineral resources have attracted many people to this area.

North of the Ohio River you can trace a line of larger cities westward. It includes Wheeling, Columbus, and Indianapolis. These cities mark the line of the old National Road, the first road into the Middle West. Once, long ago, settlers streamed westward along this road. Lumbering wagons jolted eastward, filled with wheat and corn, with hams and barrels of salt pork. Between them walked herds of cattle and droves of squealing pigs on their way to market. Fast horses raced along the road, pulling brightly painted stagecoaches. You can read from the historical map for 1840, page 376, that settlers followed this road westward.

The days when the National Road was the greatest highway of the Middle West are far in the past, but we can still trace the road on the map by the cities its traffic helped to build. Many present routes of trade and travel are marked by lines of cities. If you are interested, you can study maps and find some for yourself.

Find a line of cities running north and south a little east of the hundredth meridian. The hundredth meridian in itself does not mean anything, of course, but if you remember your earlier geography you know that it happens to mark very nearly one of the great dividing lines between regions. If you have

forgotten, look at the map on pages 378–379 for elevation, the one on pages 364–365 for rainfall, and the one on pages 370–371 for natural vegetation, as well as the one on pages 374–375 for population.

The larger cities are division points on the railroads running west. They were chosen for this purpose so that engines could be repaired and serviced before they started on the long haul across the dry, sparsely populated Great Plains. The railroad shops gave these cities a great boost.

You can see for yourself that the western half of the United States has a sparse population, compared with the eastern half. It has fewer people than the eastern half, and they are grouped differently. In other words, the population pattern is different. On the population map, vast areas of the West are in the color that stands for less than two people to the square mile. There are no large, very densely populated areas like those in the East.

Scattered over the West, however, are small areas of denser population. Find one stretching north and south through central California, one along the Snake River, several in eastern Washington, one east of Great Salt Lake, one in central Arizona, one in northern Colorado, and one along the Rio Grande in New Mexico. Every one of these spots represents irrigated land.

Vast stretches of farm and grazing land, few houses, and a little-traveled road all indicate a sparsely populated region. The picture was taken on the plains of western North Dakota.

Library of Congress (Vachon for FSA)



You see, there is a relation between population pattern and natural resources. There is a relation between natural resources and the work people do. Before you finish this book, you will have found many more examples. So far all the examples have been taken from North America. That is only because you know your own continent best, not because examples would be hard to find on other continents.

Why there are uninhabited lands.

Turn to the world population map on pages 372-373. This is not the same kind of population map as the one you have just been using. The same kind of map could be made for other parts of the world, but not for all of it. Such a map must be made from careful, accurate census figures. The figures must be given for small areas, and they must tell how many people live in cities and how many live in the country. Not all the countries of the world take censuses that provide enough information.

On the world population map, two shades of color stand out. They are bright red and yellow. Bright red stands for areas of very dense population. Yellow stands for uninhabited areas—areas that have no population at all.

The largest areas of yellow are in the polar regions. They are lands always covered with ice and snow. Such places have no resources that people can use now. This is not the same as saying that they have no resources. It is known that Antarctica has coal and other valuable minerals. It is very likely that Greenland has mineral resources. If the world ever needs these resources badly enough, people will probably invent ways of getting them. When they do, at least a few miners and a few people to operate transportation systems will live in these regions.

These uninhabited polar regions have another resource which may sometime become highly valuable. This is location. It is known already that many changes in weather in the rest of the world originate in

the polar regions. Scientists believe that a further study of polar weather will make possible more accurate weather forecasting. Therefore, some of the regions now uninhabited will have a few little communities of scientists at weather stations.

Then there is the probable extension of great-circle air routes into new regions. Of course you know what a great-circle route is. It is the shortest distance between two places on the earth. On a globe find the great-circle routes from San Francisco to Paris and from Buenos Aires to Melbourne, Australia. Both of these great-circle routes cross uninhabited polar regions.

Planes could fly either of those distances nonstop, but it is not likely that commercial air liners, heavily loaded with passengers and freight, will make such long flights. They need help from the ground. They need landing fields where they can get fuel and oil and where repairs can be made. They need landing fields when bad weather makes flying unsafe. They need radio stations to send them weather reports and radio beams to guide them. There should even be hotels where passengers can stay for a few days if it becomes necessary.

Other groups of uninhabited areas lie in central Asia, in Arabia, in North Africa, and near the Tropic of Capricorn in Africa, South America, and Australia. These regions are uninhabited because of dryness. They have resources. They have soil in which plants could grow, and most of them have a long growing season. The essential resource they lack is water.

It is possible that these regions may not always be uninhabited. Scientists might discover a way to irrigate them. We do not know how it could be done, but stranger things have happened. Discoveries of valuable minerals also would bring people to the driest desert. There are miners in some very dry areas in Australia and on the Pacific slopes of South America.

South America has another group of uninhabited areas. They lie in the tropics.

Here there are timber resources and possibilities for growing tropical crops. Disease, insects, heat, and transportation difficulties have kept the people away. These, however, need not be unconquerable difficulties. Some people consider the tropics the great storehouse of the future.

Lands of many people. In looking for densely populated regions, consider the ruled red areas as well as the solid red. These two symbols give you all the land with more than 125 people to the square mile. The two symbols together cover only a small part of the map. North America has only a few small areas with so many people. In South America the areas are even smaller and fewer. Australia has none, except the metropolitan districts of its great cities. Africa has a few. Europe and Asia are the two continents with really huge areas of dense population.

There are two kinds of densely populated regions in the world. The region you have studied in the eastern United States is typical of one kind. The much larger one in Europe belongs to the same class.

In these regions most of the people live in cities and towns. They work in factories, on railroads and ships, in offices, telephone exchanges, and stores; they build houses, bridges, and roads; they are doctors, teachers, lawyers, actors, musicians, artists. They work in hotels and restaurants; they clean the streets; they collect garbage.

Some things are easier to understand if they are shown in graphs. Turn to the second graph from the right at the top of page 381. This shows the kinds of work done in the northeastern part of the United States. At the last census the total population of the area was almost 35,977,000. Of these about 12,834,000 were employed.



Ewing Galloway

At the end of each day's work a throng of workmen like this leaves a huge, modern factory. This is a common sight in the world's industrialized areas of dense population.

The rest were children, students, housewives, old people, and other people who for some reason were not employed. The graph represents only the employed workers.

The graph is made up of columns of color. The key tells you that each column stands for a group of occupations. The height of each column shows the percentage of all workers in that occupation. Imagine you have a strip of paper one hundred inches long. In the Northeast, 617,732 people are farmers, fishermen, and forest workers. That is about 5 percent of all the workers, or five one-hundredths. Five inches of your strip of paper stands for them. The man who drew the graph worked out the length of the columns in just that way. He imagined he had a long column to stand for all the workers, and then he divided it into hundredths to show percents.

The graph shows that less than one worker in twenty is a farmer. Less than three out of a hundred work at the production of fuel and power, although the section includes the

coal-mining regions of Pennsylvania. Less than two out of a thousand work in other mines and quarries, though we hear much about stone quarrying in New England.

Now look at the occupations that are carried on mainly in cities. More than thirty-two workers out of a hundred work in factories. Not all of them operate machines. Many of them are in offices or traveling over the country selling the products, but they all have something to do with manufacturing. Almost five out of a hundred are in the building industries. Six out of every hundred workers are in the transportation and communication group. Almost 18 percent have something to do with trade. Almost twenty-nine out of a hundred are in the service industries.

Now look at the graph for Great Britain on page 389. The British census does not group its workers in quite the same way, but the groupings are close enough for comparison. The graph is amazingly like the one for the northeastern states. In both areas about the same percentage of the workers do the same kinds of work. You

may think of the two areas as typical of industrial regions with dense populations.

An example of the other kind of densely populated region is found in much of southeastern Asia. India is part of this region. There is a graph for India on page 389. More than 67 percent of the people are farmers, fishermen, and hunters. Less than 10 percent are in manufacturing, less than 2 percent are in transportation, a little more than 5 percent in trade, and less than 10 percent in the service industries. Only a little more than a fourth of the workers are in the occupations that are usually carried on in cities.

Look at the graph for Egypt on page 391. In Egypt the valley of the Nile is very densely populated. Judging from the graph, to which kind of densely populated region does it belong?

Workers and resources. Everything we have is produced by work applied to the resources of the earth. In densely populated industrial regions, much work is applied to many different raw materials. Machines

In these crowded farm lands of southern China, each clump of trees shelters a village of farmers. Since the land must be divided among many people, the share of each farmer is slight indeed.

CNS from Paul Guillumette, Inc.



are used to make the work accomplish more. As a result, the people have a great many things to use. In densely populated farming lands, such as India, much work is applied to a few resources. These lands are not poor in resources, but most of the people try to make a living from just one resource,

the soil. There are so many people that each family can have only a very small share of the land. No matter how hard a man works, he cannot produce much because he does not have enough resources to use. You will understand all this much better when you have finished reading this book.

A WORKSHOP ABOUT WORKERS

Everything in this book concerns you. There is not a chapter in it about anything that is completely strange to you. It is about people who work, and that includes almost everyone in the world. It includes almost everyone in your community. It includes you, too.

Your Community as a Laboratory

Work is so close to you that you can study it in your own home. You can have a share in it yourself. Look at the Table of Contents on pages iii and iv. How many of those occupations can you actually try for yourself? That is something your class might talk about now. Additional suggestions will be made later in the book.

If you had lived two hundred years ago, you would probably have tried most of those occupations while you were still a small child. The members of a farm family produced at home almost everything they needed. Manufacturing was carried on mainly by craftsmen who worked at home. Stores were likely to be little shops in the front room of the dwelling house.

Children were expected to help their parents. They saw the work going on, and they had a share in it themselves. Now most workers do their work away from home. Except on farms, boys and girls seldom see their fathers at work. Many of them know very little about the work done by members of their own families.

How much do you know about the work your father does? Did you ever ask him to tell you about it? Ask him to tell you the purpose of his job, what useful result his work accomplishes. Find out what skills he must have and what he needs to know in order to do his work well. Other members of your

family may work, too. Your neighbors work, and your parents' friends. Ask them to tell you about their work.

WORK CAN BE FUN

If you have not yet learned that work is fun, now is the time to find out. Start a definite piece of work, such as making a cake, a table, or a garden. Think over the things you might make. Then choose one. You will find pleasure in learning to handle materials and tools, in your own growing skill, and in the product of your work.

WHAT WOULD YOU LIKE TO BE?

Most boys and girls think a great deal about the work they would like to do when they grow up. What would you like to do? Ask yourself the following questions:

1. If I chose this kind of work, just what would I be doing all day?
2. What knowledge and skills would I need?
3. Do I know enough about this kind of work to be sure I would like it?
4. What can I be learning now to prepare myself for the work I want to do?
5. Would my work be of any real use to the world?

YOUR COMMUNITY ON THE MAP

Turn to the population map, pages 374-375. Your community belongs somewhere on that map. If you live in a city of more than 10,000 people, your city is on the map. Answer the following questions about it.

1. Does your city stand alone or is it part of a metropolitan district?

2. In which size classification is it?
3. Is it in a densely populated region or a sparsely populated region?
4. Is your city on the historical maps, or was it started too recently for that? If it is on any of the historical maps, which one is the first to show it?
5. Has your city grown larger since the time of the first map that shows it?

If you live in the country or in a small town, find the location of your community and answer the following questions:

1. What is the density of population in the area around your home?
2. When was the region settled?
3. Has the population grown denser since the region was first settled?
4. What is the nearest city shown on the population maps?
5. Which map is the first to show it?

Test Your Skill and Knowledge

You have used two new kinds of graphs in this chapter. The next two activities will show how well you can read them.

A POPULATION GRAPH

In each of the sentences that follow, choose the correct date from those given. Get your information from the graph on page 361.

1. No city in the United States had a population of one million people in (1860, 1880, 1910, 1940).
2. In (1790, 1870, 1900, 1920) there was one city with more than 2,000,000 people.
3. The first census that showed five cities with more than a million people was (1830, 1850, 1930, 1940).
4. New York began its fastest growth about (1790, 1880, 1890, 1930).
5. The first census that showed Chicago with more people than Philadelphia was (1850, 1880, 1890, 1920).

OCCUPATION GRAPHS

The graphs on page 380 show the occupations of people in eight United States cities. The length of each line of color stands for the percentage of the total working population in each group of occupations.

The cities are Chicago, Detroit, Houston, Kansas City, Los Angeles, New York, Seattle, and Washington. Identify the cities from the following descriptions.

1. Two cities with more people in manufacturing than in any other group of industries. Service industries are second.
2. A city which has more people working in the service industries than in all other industries together. Trade is second. There are only a few more in manufacturing than in either the construction industries or transportation and communication.
3. A city that has more people in the service industries than in any other group. Manufacturing is second and trade third, with those who work in transportation and communication the fourth largest.
4. A city that has more people in the service industries than in any other group, with trade second. Manufacturing and building together employ more people than trade. For city people, an unusually large number are in the mining industries.
5. Three cities in which the service industries are the largest group. Trade is the second group and is a little larger than the manufacturing and building-industry groups together. The number in transportation and communication is about half as large as the number in manufacturing.

WORDS YOU SHOULD KNOW

In each chapter of this book you are introduced to a few new terms. Those you should learn are printed in *italic* type. The following paragraph has all the terms that were printed in *italic* in this chapter, but some are in the wrong places. If you know the meaning of the terms, you can correct the paragraph.

The area from Boston to Washington, D.C., has a *graph* unlike the pattern of any other region on the map on pages 374-375. *Urbanized areas* from Europe who remained in the seaports account for part of the population. Notice that the map shows four cities with more than a million people in this region, while the *census* on page 361 has only two. The map shows *metropolitan districts*, including not only main cities but also suburbs and *immigrants* in the country. The *population pattern* of 1930 was the first to count people in this way.



Hunters and Fishermen

WILD FOODS ARE GOOD

Have you ever gone fishing? Have you ever gathered wild berries or nuts or mushrooms? If you have not, you have missed a lot of fun. You have missed a lot of extremely good food, too. No fish from the fish market ever tastes quite so good as the one you catch for yourself. No farm-grown fruit ever has quite the tang of the wild fruit you gather from the woods and fence rows.

On the map above, the large dark areas show regions in which most of the people live on wild foods; but even in the more densely populated parts of North America people use a few wild foods. Wild berries, plums, cherries, crab apples, grapes are made into jams, jellies, and pies. Hickory nuts, walnuts, pecans, and hazelnuts are gathered wherever they grow.

In some parts of the country farm women go out in the early spring to gather "a mess

of greens." The plants used as greens are kinds we usually call weeds. Someone has said that a weed is only a plant growing where people do not want it to grow. In the woods, in uncultivated pastures, and along roadsides these plants are not weeds at all. They are just wild plants. You never tasted a dish of spinach or chard that was half as good as a well-selected mess of greens. The names of a few favorites are dandelion, dock, sorrel, wild lettuce, plantain, and lamb's-quarters. They may be used alone or in any combination.

If your library has a file of *Nature Magazine*, you might like to read an article in the June-July, 1942, number. It begins on page 295. The article was written by Claire Norton and the title is, "Would You Starve?" The author says, "I can think of no spot—desert, mountain, woods, or plains—and no

season, excepting perhaps the dead of winter and in a howling snowstorm, where starving would become an unavoidable tragedy."

Do the people of your community or region use any wild foods? Whether or not they use wild foods now, they certainly used them in the past. To start your community study for this chapter, try to find out three

things: (1) What wild foods did the Indians of your region use? (2) What wild foods are still used in your region? (3) What wild foods can be found now in your region, whether they are actually used or not?

Before you go on, turn to page 50 and read the Workshop. It will help you to plan and organize your study.

FOOD WAS WHERE THEY FOUND IT

Long, long ago, the ancestors of every one of us lived on wild foods. They fished, hunted, and collected wild plant foods. Their customs and most of their thoughts, probably, were centered on their ways of getting food. The best hunter was the great man of the community. Probably he was recognized as chief, for he was the best man to plan the hunts. The woman who was most successful at finding wild plants was admired and honored. The other women looked upon her as a leader.

Your Ancestors Were Hunters

What we know about early hunting and fishing comes from the work of anthropologists, scientists who study peoples that do not have written records. In Europe anthropologists have found thousands of flint spearheads from far back in the Old Stone Age. On the floors of caves, in shelters under overhanging rocks, and in the open along river valleys they have dug up the ashes of prehistoric fires. In and around the ashes they have found the bones of many animals. The bones are charred, showing that the meat on them was roasted over the fires. They show the marks of stone tools, indicating that the animal was cut up and the bones were split so that the diners could get the marrow.

Stone Age hunters and fishers. Near the end of the Old Stone Age a great ice sheet covered northern Europe. Southern

Europe was cold and bleak. In caves in southern France and northern Spain lived people who were very artistic, for their time. On the walls of the caves they painted pictures of animals. Their paints were pigments dug from the earth and mixed with the fat of animals. The people also modeled animal figures in clay and carved figures on their tools.

Anthropologists who have studied these people believe that the pictures they drew show the animals they hunted. There are pictures of cattle and horses, then wild in Europe. There are bison, although no bison have lived in Europe within historic times. There are reindeer, such as now live in the Arctic regions. There are rhinoceroses and mammoths with long, woolly hair. A mammoth was a kind of elephant.

It took more than courage to kill those big, dangerous animals. It took teamwork and good weapons. The people had well-made flint-tipped spears of different sizes and weights. Some of these were evidently meant to be thrown. They had axes and knives of stone.

On some of the shores of Europe are great heaps of shells that look like hills. Mixed with them are fishbones, the bones of a few land animals, stone and bone implements, and the ashes of old fires. Here lived people who got most of their food from the sea. They ate mainly oysters and other shellfish. These people were not very sanitary. They threw down the remains of their meal wherever they happened to have eaten it.

The shell-heap people apparently threw away the shells and lived on top of the growing pile.

They caught their fish with hooks, spears, traps, and nets. Fishhooks are a very old invention. There are fishhooks carved from bone and shell dating far back in the Old Stone Age. The hooks are shaped like modern fishhooks, even to the little barb, pointing backward, that keeps the hook from slipping out of the fish's mouth. The people also had fish spears. These were light spears, usually with barbed heads of bone. Some were the special kind of spear called a harpoon. A harpoon has a loose head that stays on the shaft while the harpoon is thrown. When the head is fast in a fish or other animal, the shaft drops off. The fisherman or hunter pulls in his catch by means of a line fastened to the head of the harpoon. Nets and traps are also old inventions. It is quite likely that people first twisted fibers together to make cords for nets. We call the process spinning and use it to make thread. Thus the textile industry may just possibly have had its beginning in fishing.

A sparsely populated world. The earth did not have many people when everyone lived by hunting, fishing, and collecting. When people depend upon what the earth produces naturally, there is not enough food for many people. We, too, get everything we have from the earth, but we help the earth out. We make it more productive, so that it will support more people.

Everyone knows that the Eskimos are a hunting people. In part of the Canadian Arctic there is a group of Eskimos who are not very prosperous. The population has grown too dense. For each Eskimo there are only forty-three square miles of land and



Courtesy British Information Services

Africans fishing with nets and with traps that look like baskets. People of long ago used similar ways of getting food.

two miles of coast line. That is not enough. The Canadian government has to give extra food to the Eskimos of this region.

Primitive People in Our Own Time

People who live by hunting, fishing, and food gathering are called *primitive*. The word can be used to describe anything that is in an early and undeveloped state. We speak of primitive people, but we really mean people with primitive ways of living. Primitive people have not yet traveled far on the way to civilization. They are not stupid. They are people who use the earth's resources in a simple and direct way.

Bushmen of the Kalahari Desert. The only primitive people left in the world live in regions where the resources are very scanty or hard to use. Among the most primitive are the Bushmen who live in the Kalahari Desert in southern Africa. The Kalahari is



LIFE Photograph by N. R. Farbman © TIME, Inc.

Education among a hunting people—the Bushmen of the Kalahari Desert. The man is teaching the boy how to hunt with a bow and arrow.

not a very dry or barren desert. Most of it is a dry grassland, really. Besides the grass, there are many other plants, including some with beautiful flowers and some with edible bulbs and roots. Herds of antelope graze on the grass. Ostriches lay their huge eggs in nests on the ground. The Kalahari is not a bad place for a hunting people.

Bushmen are very skillful hunters. They use bows and arrows and spears. The picture shows what their bows look like. The boy is learning how to shoot. Bushman bows are not very powerful, and hunters must get close to the game. One trick for getting close to the game is the use of a disguise. A hunter dresses himself in an ostrich skin, with a long stick to hold up the head. Then he tries to act like an ostrich. If he is a good actor, he can get close to an animal without frightening it.

While the men hunt, the women collect other food. They spend much time burrowing in the ground with digging sticks. They are not always digging for roots and bulbs. Sometimes they dig for ants' eggs and insects. An ostrich's nest is a valuable find. One of the large eggs will make a meal for several people.

The Bushmen build no houses except simple temporary shelters of branches. They wear few clothes. They have no possessions except weapons, ostrich-egg bowls, digging sticks, and ornaments. They are intelligent

about their business of hunting, but they are really living in the Old Stone Age. There would be no use in making an occupation graph for them. They are all hunters.

Stone Age living of the Eskimos. The map at the beginning of the chapter shows a region of hunting and fishing people in the Far North. It stretches almost around the earth, but this still does not mean that there are many hunters and fishermen.

In your study of geography you have undoubtedly met the Eskimos many times. Maybe you thought there were a lot of them. If all the Eskimos in the world decided to get together and build a city, it could be shown only as one of the little red dots for the smallest cities on the population map on pages 374-375. According to the latest census figures, there are about 40,000 Eskimos in the world. Of these, about two-fifths live in Greenland, two-fifths in Alaska, and one-fifth in Canada. A few live along the coast of Labrador. All the Eskimos in Canada, gathered in one city, would not even make a red dot on your population map. There are only 7700 of them, spread over the tundra region from the tree line far into the Arctic islands. The density of population is one Eskimo to 115 square miles.

There is a word you need to know in talking about ways of living of different peoples. That is the word *culture*. When we talk about the culture of a people, we mean all their ways of living. We usually mean even more than that. The culture of a people includes what they think about life, as well as their ways of living and working. It includes their ideas about government, religion, art, and right and wrong, as well as their skill in using tools and the kind of houses they build.

Culture is one of those words that do not have a single, exact meaning. You have to get the feel of it by noticing how it is used. It is quite correct to say that the Eskimos had an Old Stone Age culture, although we have no idea what the people

of the Old Stone Age thought about anything. It is also correct to say that the Eskimos have adopted much of the culture of the white people, giving as examples woolen clothing, rifles, motorboats, reading and writing, trading, and religion.

Eskimo culture had to be built on the poor resources of the North. These are snow, ice, small plants, a little driftwood along the shore, and animals—especially animals. Before traders came, the Eskimos depended upon animals for nearly all their food, for all their clothing, and for most of their shelter, fuel, and transportation.

Most Eskimos lived along the coast—and still do. In the Arctic there is more animal life in the ocean than on land. Fish, seals, walruses, and whales swim in the icy water. Polar bears wander over the ice.

There are more animals in the ocean than on land because there is more food in the ocean. All life depends upon plant life. Only plants can draw their food directly from the earth and the air. Meat-eating animals may eat meat-eating animals that eat other meat-eating animals, but somewhere the chain must come to animals that eat plants. Meat-eating animals cannot live just by eating one another. Eskimos eat seals, seals eat large fish, large fish may eat

small fish, small fish may eat shrimps; but the shrimps eat plankton. Plankton is made up of tiny living things, some so small that they can be seen only with a microscope. Most of them are plants. They do not have stems or leaves but are just blobs of green.

The word is worth learning, for plankton is one of the great natural resources of the earth. It is the basis of life in the sea. It is eaten, not only by small animals such as shrimps, but by large fish and even by some kinds of whales.

A Stone Age culture goes modern. In the old days all Eskimos were subsistence hunters. The term means that they ate the meat of the animals they killed and used the skins for clothing and bedding and as covering for tents and boats. Changes have come to the Northland, but they have not changed the people's dependence upon animals. Most Eskimos are now commercial hunters as well as subsistence hunters. They hunt to get products for sale to traders as well as to get food and clothing for their own use.

Dotted over Arctic North America are fur-trading posts. The Eskimos hunt and trap fur-bearing animals during the winter. In the summer the hunters take their furs to the nearest trading post. There they trade

Hunting and fishing people at work. The Eskimos are spearing fish trapped inside the circle of stones.

Department of Mines and Resources, Bureau N. W. T. and Yukon Affairs



the furs for goods from the outside world. First of all, a modern Eskimo hunter wants a good rifle and ammunition for it. Most Eskimos now have wooden boats bought from the traders. Many are motorboats. From the shelves of the traders' stores, the Eskimos buy knives and axes. The women choose kettles and other cooking utensils, needles, and jewelry. Both men and women buy clothes and canned food, especially fruit.

We do not have accurate enough figures to make a graph of Eskimo occupations. We do know that it would not now show 100 percent hunters and fishermen. There are trading ships in the North with Eskimo crews, and there are a few Eskimos in other occupations. A good many Eskimos are herdsmen, owning herds of reindeer that graze on the tundra. The first reindeer were brought from Lapland to Alaska by the United States government. Later the Canadian government bought reindeer in Alaska for the Canadian Eskimos. Not all the tundra supplies food for the reindeer, and only a small percentage of Eskimos have them.

In spite of the cold, darkness, and scarcity of resources, the Eskimos do not live

shivering and unhappy lives. They are a gay and cheerful people. They like to go visiting and have parties, and they love their homeland, just as you do.

The Eskimos are born in the Far North, and that is their home. They can be neither well nor happy in other regions. The governments that control the Far North are trying to help the Eskimos; but, so far as we can see now, the Arctic lands can never support more than a very sparse population. Mines, weather stations, and airfields may bring more people to a few areas. A few Eskimos may find work at such places, but for most of them hunting, trapping, and fishing seem to be the only possible occupations.

Hunters in the great forest. South of the tundra lie the great northern forests. They cover a vast region stretching southward from the edge of the tundra. The forest is made up mainly of coniferous trees. You may be in the habit of calling them cone-bearing trees. "Coniferous" is a grown-up word that means exactly the same thing. Turn to the vegetation map on pages 370-371 to see how far this forest extends.

The northern part of the forest is too remote to be used for lumber, too cold for farming. In winter it is even colder than the tundra. In North America the forest people are Indians. Like the Eskimos, they have always been hunters, fishers, and collectors. Collecting is more important here than among the Eskimos, for there are a few berries and other plant foods in the forest. But the Indians are mainly hunters, trappers, and fishermen. They sell furs to fur traders.

As you can see from the population map, the forest does not have many people. There are more than in the tundra, but still fewer than two per square mile. The forest is not quite so lonely

Indian trappers in the northern forest region. The men are stretching muskrat skins on wooden frames for drying.

National Film Board of Canada



as the tundra. There are mining areas. In a few sheltered spots there are small farms. A few railroads cross parts of the forest, and there are steamboats on some of the large rivers. Of course, there are also thousands of square miles of unbroken forest, but airplanes fly even over these areas.

Not all the furs from the northern forest region are the skins of animals caught by trappers. Some are the products of fur farms. The very first fur farmers raised only silver foxes. When fox farming had proved successful, fur farmers began to raise other kinds of fur-bearing animals.

Hunters of Europe and Asia. The tundra and the northern forest are not just American regions. Find them on the vegetation map, pages 370-371. They are belts that reach all the way around the earth, where there is land. Outside of North America, these two belts are almost entirely in the Soviet Union.

In the tundra region of Asia are people who look very much like Eskimos. Their culture is much like that of the Eskimos. In fact, the Eskimos are probably quite closely related to them. Anthropologists have discovered that the ancestors of both Eskimos and American Indians came from Asia. No doubt they brought their culture with them, already fairly well developed. In the forests of Asia there are other people who look and live much as the northern Indians do.

Long ago, Russian fur traders opened trading posts eastward across Siberia. In the eighteenth century they established posts in Alaska. Moving southward, they even built one post in California. After a few years they gave up the California post, but they kept Alaska until 1867. The United States bought it in that year.

Furs are still important in northern Europe and Asia, but a smaller percentage of the people are hunters and trappers than in America. More of the forest has been cleared for farming, and much more lumbering is carried on in the Far North.

Your Neighbors Hunt and Fish

We can scarcely imagine now the numbers of wild animals that once walked, flew, or swam on this continent. Never again will there be such vast numbers of wild animals as there used to be. There are too many of us. We do not leave them room. Still we do not need to be afraid they must disappear entirely. Thanks to conservation, their numbers are actually increasing. Conservation is more than laws limiting hunting seasons and the number of animals that may be killed. Animals must find food. We have great areas of wasteland—land that is too cold or too wet for farming, or that has a soil too acid or too sandy. We have thousands of square miles that should remain forested to keep the soil from washing away. Why not leave such areas for the wild animals?

Even in regions of fairly dense population there are still enough wild animals for commercial trapping. More than 8,000,000 muskrat skins went to market in a recent year from Louisiana. Large numbers of other animals were trapped in the same state, especially mink, opossum, and raccoon. No other state in the whole United States produces so many fur skins, but at least a few are sold from every state. Some of the animals are grown on fur farms, but most are wild. Some are caught by full-time trappers, but a great many are trapped by farmers and farm boys.

Hunting and fishing for sport. Probably right now, as you read this, farmers in your own region are out rabbit hunting. There are still rabbits almost everywhere in the country. Quail, pheasant, grouse, and wild ducks are hunted in many places. Hunters travel hundreds of miles from more densely populated regions to shoot deer in northern New England, in the Appalachians, in parts of the South, in the upper Great Lakes region, and in the West. Most game animals are protected by law. Hunting is allowed only during a short open season.

Many more people go fishing than go hunting. To great numbers of people a holiday or a vacation just means a chance to go fishing. Quite probably you or some of your classmates have gone fishing.

Since this book is about occupations, we cannot spend much time on hunting and fishing for sport. Sportsmen are only playing at getting a living by old-time methods; but their play makes a living for many other people. Think of the people who work to make their sport possible or to regulate it.

Vacation hunters and fishers must have places to stay. There are hotels and camps for them wherever sportsmen go in large numbers. In the wilder parts of the country, hunters and fishers need guides. Along the coasts and on the larger lakes are men who own boats and make a business of taking out fishing parties. Then, too, there are all the people whose job is the making of fishing tackle and other equipment for fishers and hunters and the officers who enforce the hunting and fishing laws.

THEY ARE ALL FISHERMEN

A fisherman is not necessarily a man who catches fish. That, of course, would be a more reasonable meaning for the word, but language is not always reasonable. Animals that live in the water are not all fish, but the attempt to catch any of them is called fishing. We talk about fishing for lobsters, crabs, shrimps, oysters, clams, and sponges, although none of these animals is a fish. Whales and seals are no more fish than elephants are, but we talk about whale fisheries and seal fisheries.

Out on the Pribilof Islands, west of Alaska, almost three million fur seals come ashore every summer. The rest of the year they scatter southward in the ocean. The seals belong to the United States government. Each year limited numbers of selected animals are killed by men who are hired by the government. The product is fur, but the United States government lists its valuable seal herd under fishery resources. The seals are not fish, but they spend most of their lives in the water. The business of capturing any kind of water animal is usually called fishing. The United States Fish and Wildlife Service even includes a description of valuable seaweeds in a booklet on fishery resources. The workers you will read about in the rest of this chapter can all be called fishermen, whether or not the animals they catch are actually fish.

Fish and Fishermen

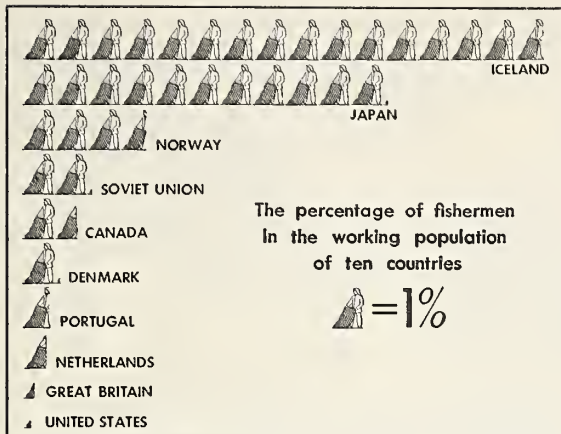
Simple Simon went a-fishing
For to catch a whale,
And all the water he had got
Was in his mother's pail.

You probably heard that nursery rhyme when you were a small child. Even at the age of two or three you knew that Simon was a very silly boy. You don't go fishing in a pail. You don't go fishing just anywhere in the ocean, either.

Where fishermen work. Except for a few very salty lakes, all bodies of water have fish in them. People go fishing even in small ponds and streams, but the fishing grounds of the commercial fishermen are large rivers and lakes and the ocean.

In the ocean, most fishing is carried on in water less than a hundred fathoms deep. A fathom is a measure used by seamen. It equals six feet. For the ocean, a hundred fathoms is shallow water. Turn to the map on pages 362-363 and look at the color symbols showing ocean depths. Most of the ocean is more than 10,000 feet deep.

From the coast lines of all the continents the sea bottom slopes outward gradually, sometimes for hundreds of miles. Then it drops off quite suddenly to much greater depths. The gently sloping portions are



In the United States only one in five hundred of the working population is a commercial fisherman; in Canada about one in sixty-five. The graph on this page shows the percentage of fishermen in the working population of a few other countries.

What a fisherman must know. A fisherman must know the fishing grounds on which he works. He must know the depth of the water and whether the bottom is sandy, muddy, or rocky. To catch a fish, a fisherman must know where it is to be found and what it will do. A fisherman also needs to know what to expect of the weather, how to handle boats, how to use the tools of his trade and how to keep them in working order, how to prepare his catch so that it will not spoil, and where to take it to market. Besides all this, he must know what laws apply to his fishing, what kinds of fish people will buy, and what prices he will get.

called continental shelves. They are the world's great fishing grounds.

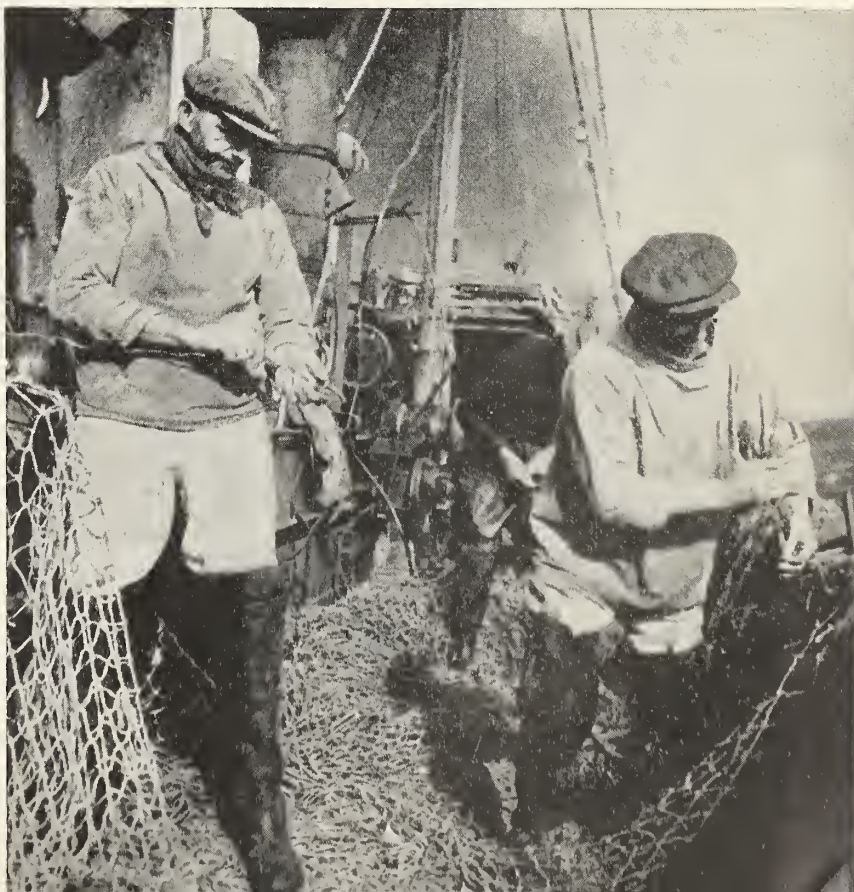
The Northern Hemisphere has more shallow water than the Southern Hemisphere because it has more land and therefore more areas of continental shelf. It also has many times the number of people, all of whom need food. These are the two principal reasons why most of the world's great fishing grounds are north of the equator. About 98 percent of the fishery products of the earth are taken on fishing grounds north of the equator.

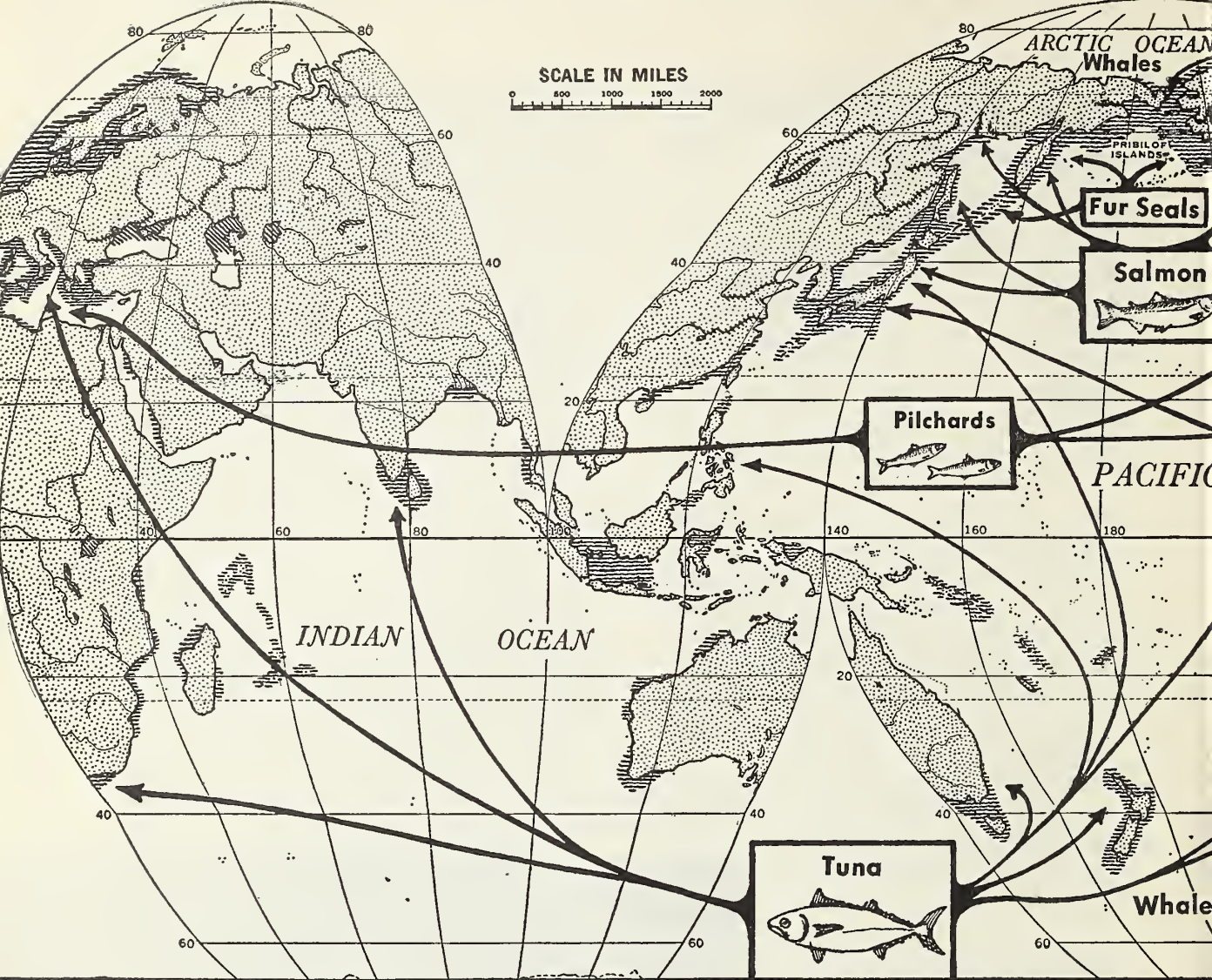
How many fishermen? Fish and other sea animals are one of the earth's greatest food resources. They supply billions of pounds of food each year. In addition to food, they furnish many other products. Vitamins, fertilizer, poultry and stock feed, glue, oil for paint, and skins for leather are just a few of these. Since sea products are so important, you might expect to find a great many people employed in the fishing industry. If you did expect to find a great many fishermen, you would be mistaken.

Compared with the number of farmers or factory workers, the number of fishermen is very small.

Dutch fishermen at work. They are mending their nets, which is a necessary part of a fisherman's job.

Courtesy Netherlands Information Bureau





Where the world's fishermen work.

Fishing Regions of the World

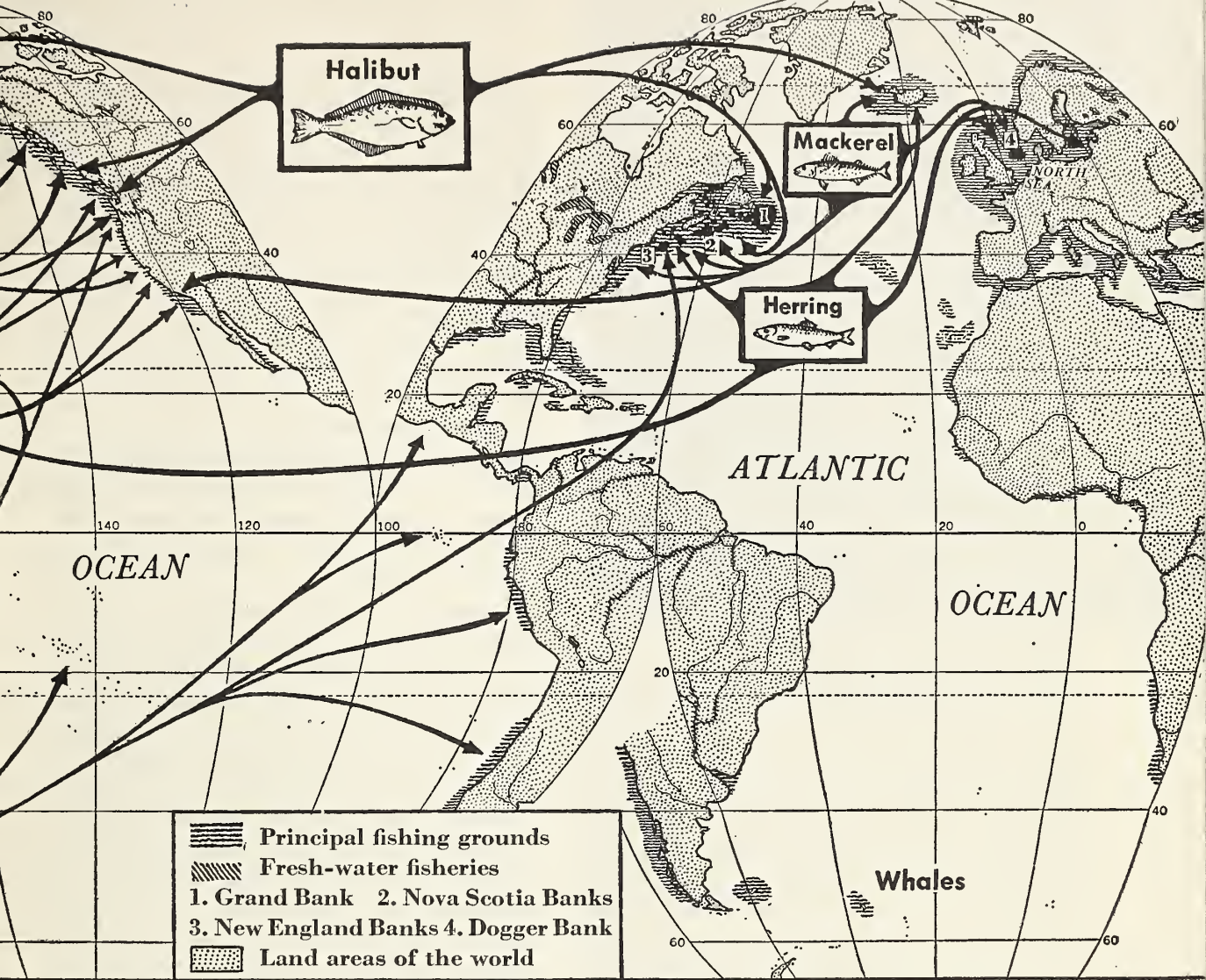
Fishermen suit their methods of fishing to the fishing grounds and the habits of the fish they wish to catch. The habits of the fish vary according to their habitats. The word *habitat* refers to the environment in which an animal lives. We may therefore organize our study around different kinds of fishing grounds. Suppose we begin with the fresh water on the continents and work outward to the wide blue oceans.

Fresh-water fishermen. In the United States less than one-fifth of the fishermen fish in fresh water. Their catch is only

about a thirtieth of the total number of pounds caught. Those figures refer to commercial fishermen, catching fish for sale.

Most of the fresh-water commercial fishing in the United States is done in the Great Lakes and in the Mississippi River and its larger tributaries. Commercial fishing is not allowed in smaller streams and lakes. There are not enough fish in them. Commercial fishermen, using nets and traps, would soon catch them all.

More than a dozen different kinds of fish are caught commercially in the Great Lakes. The heaviest catches are lake herring and trout. Most trout fishermen use gill nets. They go out in motorboats with gasoline or



Diesel engines and set several miles of nets. A gill net stands upright in the water like a fence. It has floats at the top and weights at the bottom. A fish pushes its head through a mesh of the net, but its body is too large to go through. When it tries to back out, the gill covers at the sides of its head catch on the cords of the net. The fish can go neither forward nor backward and is held until the fishermen pull up the net to collect the catch.

Whitefish are larger relatives of the lake herring and are the most popular of all lake fishes. Fishermen usually catch them with gill nets or pound nets. A pound net is a trap. Netting is fastened to stakes to make

the trap. A kind of netting fence, called a leader, extends across the path taken by many fish. The fish swim along the leader and through a narrow opening into the pound, or trap, at the end. They do not find their way out again.

Only three river fishes are important commercially. These are the buffalo fish, the carp, and the catfish. There are several varieties of each. In spring both carp and buffalo fish migrate upstream to lay their eggs. They crowd the small streams and the waters near the shores of lakes. A spear, a farmer's pitchfork, or even a garden rake will do as gear. The commercial fishermen generally use bag-shaped nets.

There are several varieties of catfish. Probably every middle western boy or girl who lives near a stream has caught small catfish with a hook and line; but those caught commercially are the big ones, mostly from the lower Mississippi and its tributaries. Fishermen set trotlines for catfish. These are long lines with short lines attached. Each short line has a baited hook.

Many farmers raise fish as a crop. A farmer may have a natural pond or lake on his farm, or he may make one by damming a stream. He puts fertilizer in the pond so that water plants will grow. Tiny animals that feed on these plants become abundant. Then the farmer gets young fish from a government hatchery to stock his pond. The fish eat the tiny animals. Larger fish also eat some of the smaller ones.

All over the world people fish in rivers and lakes. They fish in the cold rivers of the northern Soviet Union, in the Amazon and Congo, in the waters of Lake Titicaca high in the Andes, in the muddy rivers of China, in the mountain streams on tropical islands. The oceans are the real fishing grounds, however. On the map on page 23, the thin, dark lines along the coasts show where most fishermen live. Thin as they are, these lines had to be made too wide, or you could not have seen them at all.

Inshore fishermen of New England.

Every coast line has a fringe of shallow water, from sea level to a few fathoms in

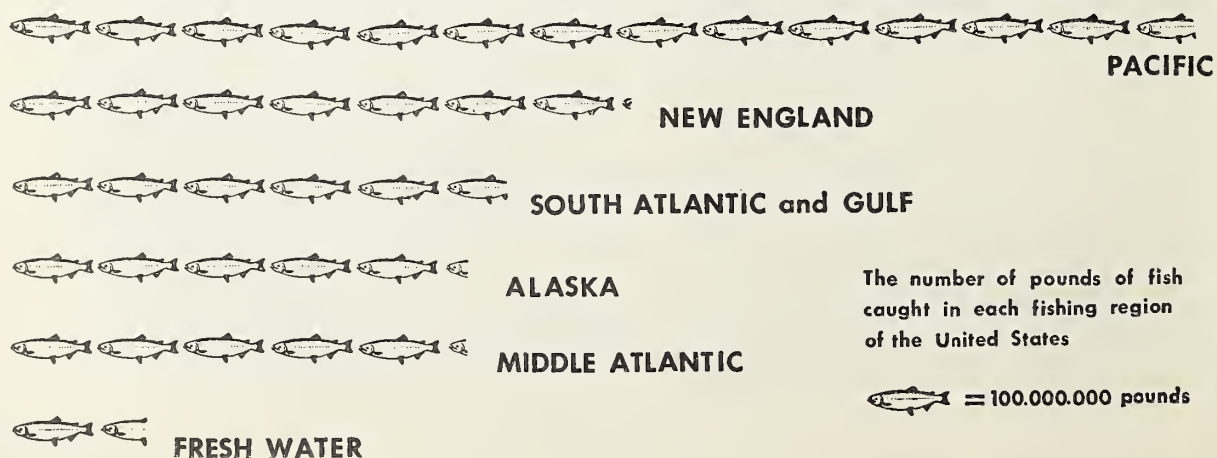
depth. It includes bays, inlets, and sounds. The men who fish in these waters near shore are called inshore fishermen. Those who go farther out are called offshore fishermen.

Perhaps the best way to study shallow-water fisheries is by region. For the United States there are four regions: (1) the New England region, which extends into Canada; (2) the Middle Atlantic region; (3) the South Atlantic and Gulf region; and (4) the Pacific coast, including Alaska. There are no exact boundaries between regions.

The most famous product of the New England shore line is not a fish. It is the lobster. Lobsters belong to a group of animals called crustaceans. Crabs and shrimps are also crustaceans.

Lobsters are not limited to the New England region. They have been caught as far north as Labrador, and their range extends south to the mouth of Delaware Bay. The *range* of an animal is the whole region in which it lives. Most lobsters live between Cape Cod and the Gulf of St. Lawrence.

Lobsters are hatched as tiny creatures that look more like mosquito wigglers than lobsters. For the first few weeks of their lives they float on the surface. In order to grow, they have to shed their skins. This process is called molting. A crustacean's skin is hard and horny. The hard skin protects the animals from their enemies, but it forces them to a very inconvenient way of growing. While they are young, they grow too big for their skins every few weeks. Then



they have to molt the old skins. The new skin that has formed underneath is soft at first, but it soon hardens.

After three or four molts, the young lobster looks like a lobster, though a very small one. It sinks to the bottom, where it will spend the rest of its life. On the bottom the young lobster keeps on growing. The largest lobster on record weighed forty-five pounds, but that is a very unusual size. Even twenty-five pounds is rare.

Lobsters can swim, backward, but they do not do it very often. They walk over the bottom on their claw-tipped legs, with the large front claws pointed forward ready to catch small fish. They grub in the mud for small animals living there. They dig burrows and hide in them, or hide among weeds or in crevices in the rocks. Always they are looking for something to eat. Sometimes a lobster finds food in a lobster pot. Then it is caught. A lobster pot is a trap. The name is misleading. The pot is not made of pottery, but of wooden slats.

The lobster fisherman's home is probably in a small town or fishing village beside a bay. He may buy his lobster pots, but more likely he makes them himself. He owns perhaps a hundred, perhaps more or less. A lobster pot looks like a box, except that the boards, or slats, have spaces between them. The spaces are wide enough to allow small lobsters to escape.

The pot is divided into two sections. The smaller section has one or two openings. To get in, the lobster must crawl through a funnel of netting. Then it must crawl through another funnel of netting to get to the second section, where the bait is. The bait is usually pieces of fish. The lobster cannot enter the narrow inner ends of the funnels to crawl out again.

The lobsterman goes out with his pots in a small motorboat or even in a rowboat if he is working close to shore. He sets his pots on the bottom. So that he can find them and pull them up again, he attaches to each pot a line long enough to reach from the



International News Photos

A young lobster. The little lobster on the fisherman's thumbnail is already five weeks old. It is ready to begin its life on the ocean bottom.

surface of the water to the bottom. At the top of the line is a wooden float. To make the floats easy to see, lobstermen paint them in bright colors. Each fisherman in an area has his own colors and pattern, so that he can identify his own pots. The lobsterman hauls his pots every day or twice a day, unless the weather is too bad. This means simply that he pulls them up to the top of the water. He takes out the lobsters and rebaits the traps.

The New England lobsterman may send his catch to fresh-fish markets, or to a plant where the lobsters are boiled and the meat is removed from the shell to be sold in packages as boiled lobster. The Canadian lobster fishermen are a long way from densely populated areas where there are the best markets for fresh lobsters. A large part of the Canadian catch is canned.

Clams are another famous product of the shore line. Two kinds are caught in New England. The range of the soft-shell, or long-neck, clam extends from Cape Hatteras to the Arctic Ocean. It is most abundant

north of Cape Cod. The other kind has several names—hard-shell clam, littleneck, and quahog. It is most abundant south of Cape Cod, and its range extends southward along the Atlantic and around the Gulf of Mexico to Texas. The scientist says clams are mollusks. The man in the fish market is more likely to call them shellfish, although they are not fish at all. Most soft-shell clams live between the lines of high and low tide. They are covered with water only part of the time. Most hard-shell clams live in shallow water beyond the tide line. They are always covered with water.

Commercial clam fishermen use a hoe or a rake or a spade like a potato digger. When the clams are beneath several feet of water, the clammers work from boats, with tongs. These are like two rakes with the handles fastened together. The rakes can be dug into the bottom and brought together. Then they are lifted into the boat with whatever clams were caught between them.

Middle Atlantic fishermen. The Middle Atlantic region lies just south of the New England region. It does not quite correspond to the section of Middle Atlantic states, for it extends all the way from Cape Cod to Cape Hatteras.

The Middle Atlantic coast might be called the land of the oyster—or should we say the water of the oyster? Except for classifying it as a mollusk, there is no need to tell you what an oyster is. Oysters are shipped to all parts of the country, and almost everyone eats them.

Oysters thrive best in brackish water; that is, the water is salty, but less salty than the water of the open ocean. Sea water becomes brackish when it is diluted with fresh water from the land. Along the Middle Atlantic coast a whole series of great rivers pour their fresh water into bays and sounds, turning vast areas into a suitable habitat for oysters. The range of these shellfish extends all the way from Canada to Mexico, but the largest production comes

from the Middle Atlantic region. Chesapeake Bay, Delaware Bay, and Long Island Sound have the greatest oyster fisheries.

Oysters spawn in summer, and one oyster may produce several hundred million eggs in a summer. No, that is not a misprint. Incredible as it may seem, the statement is true. Don't think, though, that you need to eat oysters with all your might to keep the bays and sounds from being choked with them. Most of them die because of unsuitable conditions or are eaten by other animals.

For about two weeks the infant oysters drift about as part of the plankton. During this time a very large proportion of the young oysters are eaten by the animals that feed on plankton, or they die because the water is too salty or too muddy or otherwise unsuitable. The young oysters that do not die lose their ability to float and sink to the bottom. After they sink, they can live only if they are able to attach themselves to something solid—a shell, a stone, or a piece of wood. If they happen to fall on a suitable spot, they have a chance to live. If they fall on a muddy bottom, they are almost certain to be covered up and smothered.

Once attached, the oysters never move. If too many fall close together, some will not be able to get enough food and will die. There may be plenty of room all around, but no one can move over. The best place for oysters is where a gentle current or the tide washes over them. Their gills filter out microscopic plants and animals from the water. If the water does not have enough food in it, the oysters starve.

Tongs and dredges are the gear used by oyster fishermen. Working in shallow water, a tonger needs only a rowboat and his long-handled tongs. The picture tells what a dredge is like better than words can describe it. Metal rings instead of cords make the bag. Oyster shells are too heavy for ordinary netting. The mouth of the bag is held open by a metal frame. Teeth on the lower edge scrape the oysters from the bottom. One powerboat may drag several dredges

over the oyster beds. The dredges are pulled up by machinery and emptied into the vessel.

People of the United States like oysters. They like them so well that they have eaten some beds bare of oysters. If nothing were done to increase the number, there would soon be no productive oyster beds at all.

Oyster farming is the most efficient method of increasing the number of oysters. The oyster farmer's "land" is at the bottom of the ocean. He leases it from his state government. First the farmer clears the land, dredging out old shells and stones. He then spreads shells, gravel, or perhaps pieces of wood over the ground. Now he is ready to put in large oysters for spawning. He does not need many. A few oysters will produce billions of eggs. With shells or other materials on the bottom, he gets a good crop of young oysters.

The growing of oysters now begins to sound more and more like ordinary farming. The farmer calls his young oysters seed oysters and plants them in a well-prepared bed. Later he transplants them to new beds where swifter currents bring them more food. Perhaps he transplants the oysters several times. He spreads them evenly, so that each oyster has room to grow.

In two to five years the oysters are ready to harvest. Oysters do not feed, and so do not grow, during cold weather. There is, therefore, a growing season for oysters. The longer the growing season, the sooner the oysters are ready to harvest. The farmer harvests his oysters with a dredge.

Crab meat is another well-known product of the Middle Atlantic region. There are many kinds of crabs, but only a few have



Fish and Wildlife Service, U. S. Department of the Interior

Oystermen using the common kinds of gear, tongs and a dredge.

Fish and Wildlife Service, U. S. Department of the Interior



enough meat to make them worth catching. The blue crab is the kind caught on the Atlantic coast. Its range extends from New England southward, around Florida and the Gulf of Mexico. Crabs are crustaceans, like lobsters. Their habitat is the brackish water of bays and coves.

It is easy to catch a crab in waters where crabs are plentiful. All you need do is dangle a piece of meat on the end of a string in the water. The crab catches itself. It hangs onto the bait with its large claws. Commercial fishermen catch crabs on baited trotlines, in traps somewhat like lobster pots, and with dredges. The dredges are much lighter than those used for oysters.

Crabs shed their skins as lobsters do. Before the new skin hardens, they are called soft-shell crabs. People like them for cooking whole. Hard-shell crabs go to plants where they are steamed and the meat is picked out of the shell. It is then made up in packages and carefully refrigerated. Large quantities of meat are canned.

Many kinds of fish live in the bays and sounds of the Middle Atlantic region. They are called shore fishes because they live close to shore. At least people thought they did when the name was given them. They could be caught in the bays and along the shore in summer, but in winter they mysteriously disappeared. About 1930, scientists discovered what happens to them. They go out a little way on the continental shelf, where the water is deeper and warmer.

If you are interested in the names of the shore fishes, here are a few: spot, scup or porgy, croaker, weakfish—also called squeeteague—sea trout, mullet, redfish, butterfish, and drumfish. You need not remember the names. Unless you live near the Atlantic coast, you are not likely to see any of these fishes. They are nearly all sold as fresh fish in the large cities along the coast. Menhaden are not eaten at all. The whole large catch goes to reduction plants to be made into oil and meal.

Fishing along the coast is done by one man alone or by a few men working together. The fishermen use many different kinds of gear. Some fish with a hook and line, as sports fishermen do. Many set out trotlines. Traps of various kinds are used. These may be small ones, more or less like lobster pots, or huge pound nets.

Gill nets are set across channels. Many fish are caught in trammel nets, too. Trammel nets are set like gill nets, but they are made of three thicknesses of netting instead of one. The outside layers are wide-meshed netting. Between them, like the meat in a sandwich, is a layer of fine netting with plenty of slack. A fish swims against the net. The wide meshes are large enough for

it to go through. It pushes the fold of fine mesh ahead of it through the large mesh on the other side, making a bag of netting with itself inside. One would think even a fish would know better than to get itself into such a predicament.

Haul seines are used from the shore. Several fishermen work together. The seine is a long strip of netting with weights at the bottom and floats at the top. When the fishermen see a large number of fish near shore, they fasten one end of the seine on the beach. In a small boat they carry the other end out around the fish and back to the beach. Then they haul in the seine by pulling the ends. All the fish surrounded by the seine are dragged in with it.

These methods are all used in summer when the fish are close to shore. They cannot be used in winter when the fish are in deeper water. Then fishermen on large vessels fish with otter trawls. An otter trawl is a huge funnel-shaped bag of netting. Across the bottom of the opening is a heavy beam to hold it down. At each side of the mouth are square objects sometimes called doors, because that is what they look like, and sometimes otter boards. They are fastened to the trawl in such a way that the water forces them apart and holds open the mouth of the net. A vessel called a trawler drags the trawl along the bottom. It picks up all the fish in its path, but the small ones escape by slipping through the meshes.

Southern fisheries. Another fishing region extends from Cape Hatteras southward to the tip of Florida and then around the shores of the Gulf of Mexico. Many of the fish are like those of the Middle Atlantic region. Crabs and oysters also are caught throughout this region.

In the South a business is made of sport fishing. It is not a business for the sports fishermen, but it is for the men who take them fishing. These men have boats for hire, from rowboats to large boats with motors that can go many miles offshore.

Methods are still-fishing and trolling. For still-fishing, the boat stands still and the fishermen dangle baited hooks in the water. For trolling, the boat moves slowly ahead with the hooks trailing in the water behind it.

Sponge fishing is another interesting activity of southern waters. The center of the United States sponge fishery is Tarpon Springs, Florida. Sponges are gathered also off the coasts of the Bahamas and some of the islands farther south. A sponge looks like a plant, but it is really a very simple kind of animal that lives attached to the bottom of the ocean. The sponges you have seen and used are the skeletons of the animals. The live sponge is covered with a kind of slimy skin, and the openings are lined with the same material.

There are two methods of fishing for sponges. One is used along the shore where the water is only a few feet deep. Two men go out in a rowboat. They have a water glass. Usually they make this themselves by substituting a piece of glass for the bottom of a pail. One man rows the boat. The other peers into the water through the glass. It is hard to see through the surface of water because light reflects from the surface. The fisherman holds the glass bottom of the pail below the surface and so gets a clear view. He has a long-handled hook, usually with three prongs. When he sees a sponge of the right size and kind, he reaches down with his hook, works the sponge loose from the bottom, and pulls it into the boat.

Large vessels are used in the second method. The large vessels go out to deeper water. Divers in diving suits go down and walk along the bottom looking for sponges. They have short-handled hooks to loosen the sponges and net bags to put them in. A vessel usually carries two divers, and they are the most important men in the crew. A diver's life is dangerous. Sharks swim around him as he walks along the bottom. Then there is always the danger of falling into a spot that is too deep, of tearing his diving suit, of twisting or breaking the hose that brings

him air. If he works in deep water, there is also danger of the "bends," a serious illness caused by the pressure of the sea water. The divers are proud men—proud of their courage and their skill—and they are much admired by their associates.

The South Atlantic and Gulf region has its own famous crustacean, the shrimp. Shrimps look like small lobsters without the big claws. The range of the Atlantic shrimp is from North Carolina to Mexico. The largest catches are made in the Gulf of Mexico, from Mississippi to Texas.

Only the tail of a shrimp is eaten, but a shrimp is nearly all tail. Inside the

A shrimp boat on the Gulf coast. The fisherman is shoveling shrimps into the hold, where they will be iced to keep them fresh.

Fish and Wildlife Service, U. S. Department of the Interior



shell, the tail is solid meat. It is the familiar curl of pink and white you see in shrimp salads or shrimp cocktails. Except along the coast, most shrimp goes to market boiled. Some is frozen and some is canned.

The Pacific coast. The fishing grounds of the Pacific coast extend all the way from Mexico along the shores of the United States and Canada to the Bering Sea. Inshore fishermen go out for a day at a time in small boats. Many of them fish with hooks and lines to catch fish for local markets.

The Pacific coast has its own kind of shrimps, crabs, clams, and lobsters. Its shrimps are much smaller than those of the Atlantic and Gulf coasts. Their range extends all the way from Central America to the Arctic Ocean, but they are caught only in a few places. Most of them are sold as whole cooked shrimps, which the customer must shuck for himself. Some are canned.

Pacific crabs are much larger than eastern crabs. Pacific-coast fish markets have crabs as large as dinner plates. Most of the crab meat from United States waters goes to market fresh. Most of the Canadian and Alaskan catch is canned.

The Pacific coast has three kinds of oysters, though only one is native. It is a small variety, called the Olympia oyster. It lives all the way from Mexico to Vancouver Island. The Atlantic oyster and a large variety from Japan have been brought to the Pacific coast by oyster farmers.

Clams, too, bury themselves in the mud all the way along the Pacific coast from Mexico to Bering Sea. Several varieties are used. Some are sold raw, some are frozen, and some are canned.

Spiny lobsters are the Pacific variety. They have no large claws, the only meat is in their heavy tails, and they live in warm water only. Their range is from southern California southward. Many California fishermen go to the Mexican coast for lobsters. Lobster tails are imported from Mexico and even from as far away as South Africa.

Fishermen on other shores. This book does not have space to tell about all the fishermen along all the shores of the world. Nor does it have room to tell about all the strange things they catch. Fishermen fish for seaweed on the shores of Japan and Scotland and on both the Pacific and Atlantic coasts of North America. Some kinds are used in soup. From one kind a product called agar-agar is made. It is used as a medicine, in finishing cloth, and in laboratories for growing bacteria. Other seaweed products are used as fertilizer.

Along many tropical shores, fishermen fish for pearls. Really, they fish for oysters or other shellfish that produce pearls, but their industry is called pearl fishing. Scientists believe that every pearl starts with something that irritates the oyster. It may be a grain of sand or a microscopic worm. The oyster produces a substance that covers the irritating particle. The cover is the same substance that builds the oyster's shell.

There are pearl fisheries on the shores of India and Ceylon, along the Persian Gulf, on the north coast of Australia, and around many South Pacific islands. Nearer home, pearls are found on the coasts of Venezuela, Panama, and the Gulf of California.

The pearl oysters are gathered by divers. From ancient times divers have gone down naked to collect the oysters they could gather in the space of a breath. Now in many places the divers wear helmets and rubber suits. They can stay down much longer and work in deeper water. Sometimes a diver finds a pearl of fabulous beauty and value, but he may examine a hundred oysters to find one that has any worth at all. In the shells he has a sure source of income. The oyster shells are made into buttons and ornaments.

Some kinds of fresh-water shellfish also produce pearls. Many are found in rivers of Europe and in the Mississippi River and its tributaries.

With nets and traps, with lines and spears, fishermen work along every shore.

They may not live beside the great fishing grounds of the world, but they still catch fish. The shallow waters along any coast produce enough fish to supply the people who live near by.

Fresh-water fish that go to sea. That heading might as well have been salt-water fish that spend part of their lives in fresh water. The best-known of all such fish are the Pacific salmon. Salmon are caught all along the American coast, from about San Francisco to Bering Sea. On the Asiatic side they are caught from Japan northward along the coast of the Soviet Union.

In the spring fishermen watch for the salmon runs to begin. They know when to expect them. Fish come swarming northward along the coast by the million. At the mouth of each river some of the fish turn aside and start their journey upstream. There are five kinds of salmon along the American coast. Two kinds stop in streams near the ocean; the others go on and on—those that have escaped the fishermen near the mouth of the river.

The fish do not eat. They do not stop. Day after day they swim upstream against the current. When they come to a rapid or waterfall they leap to the top and go on and on. Some follow the main stream. Others turn off into tributaries.

The fish are thin now. They have been battered against the rocks. Indians have caught many. Bears have scooped some out of the water with their big paws. Wolves have eaten some; eagles and gulls have pounced on others. Still the survivors go on. They may turn off again and again into tributaries of tributaries and then into still smaller tributaries. They act as if they knew where they are going, but scientists do not think any fish knows where it is going. Fish act by *instinct*. That does not really explain anything, for no one knows what instinct is or how it works. When all the animals of a certain kind behave always in certain ways, we say their behavior is in-



Eric Hess from Triangle Photo Service

Fishermen work along every shore. This one has been fishing off the coast of Brazil. The sail behind him belongs to his fishing boat.

stinctive. We mean that they were born with this kind of behavior set for them. The instinct urging a salmon to swim upstream when it has reached the right age is as much a part of it as its scales and fins.

The salmon do not stop until they reach cold, clear, shallow water near the source. The bottom of the stream must be covered with gravel. Now the fish are battered and nearly starved, but instinct drives them to one more task. They scoop out nests in the gravel and lay their eggs. Then the salmon die. Every one of them. The birds and bears and wolves feast for a little while. Then the streams grow quiet again. Winter comes, and ice forms over the water.

Early the next summer tiny fish wriggle up through the gravel. They find food even tinier than themselves and begin to grow. Instincts vary with the kind of salmon. Some little salmon begin to drift downstream almost as soon as they are hatched. Others

live in the streams for several years. Sooner or later, though, all of them begin their journey down to the sea. Again they have many enemies. The fish are too tiny for the bears and the wolves to notice them. They are too tiny for the fishermen to be interested. But they are not too small for the birds and bigger fishes.

In the ocean the young fish scatter. They stay in cool water and eat small fish and plankton. Seals, whales, and larger fish eat the salmon. That is about all we know of their life at sea. When they reach the right age, which varies with different kinds, instinct sends them back to the coast and upstream. There is good evidence that nearly all salmon go back to the stream in which they were hatched.

Salmon instincts create a problem for people. How can we develop the other resources of a region without destroying the salmon resource? Birds may build a nest in the same tree year after year, but if the tree blows down during the winter they will nest in another one. Salmon cannot find a new place. Instinct controls them too completely. Perhaps the land has been cleared around their home stream. Silt may have washed into the stream and covered the

gravel. The salmon do not find another place to spawn. They die without spawning. Perhaps people have built a dam across their river. If the fish cannot get over the dam, they die. They do not try a lower tributary. If young salmon swim into an irrigation canal, they never reach the ocean, and they, too, die. A young salmon's instinct forces it to swim with the current. It cannot swim back to the head of the canal and get out the way it got in.

There are ways to meet these problems. Silt can be kept from washing into rivers. Fish ladders can be built around dams. A fish ladder is a channel made up of a series of little pools, each one higher than the one before. The fish go upstream from pool to pool. Openings to canals can be screened so that the young fish cannot get in. With all that can be done, however, a densely populated, industrialized region cannot produce so many salmon as the wild streams of a sparsely populated region. That is one reason why almost nine-tenths of the United States catch comes from Alaska.

Since salmon swim upstream in rivers, it would be possible to catch every one of them. Then there would be no more salmon. For this reason salmon fishing is carefully regulated by law.

The laws are designed to let enough fish escape to keep the salmon population at about the same number. The regulations differ for different rivers. In general, they limit the size of the catch, the methods of fishing, and the kind of gear.

Most fishing is done near the mouths of rivers, either inside the mouth or in the open ocean where the fish are migrating toward the river mouth. Almost every possible kind of gear is used. Gill nets and traps are set in rivers and along the shore. Seines and other kinds of nets are used in the ocean. Many salmon are caught by trolling.

Columbia River fishermen are loading salmon from a small boat onto a larger vessel. They are on their way to a cannery.

Fish and Wildlife Service, U. S. Department of the Interior



About three-fourths of the North American salmon pack is canned in Alaska. The canneries are built along the shore, in river mouths, and in sheltered inlets. Some of them are so close to the water that the fishing vessels can bring their catches directly to the cannery wharves.

During most of the year the buildings are empty and silent. Then the time for the salmon run approaches. Whole fleets of ships thread their way northward through the Inside Passage among the coastal islands. Some are fishing vessels, loaded with nets and equipment. Others bring cannery workers, tin cans, food, and new machinery. Most of the ships sail from Seattle.

For a few weeks the canning factories hum and clatter. Fishing vessels pull up to the wharves and unload their fish. The shining fish, fresh from the sea, are carried into the buildings on conveyors. In a little while they are passing through machines that clean them and cut them into pieces the right size for canning. The meat is cooked after it is in the cans.

Soon shiploads of bright cans of salmon are on their way back to Seattle. Then the cannery workers and the fishermen are on their way back. A few people from Alaska work in the canneries or on fishing vessels, but most of the workers go north each year for the fishing season.

Several other kinds of fish go up the rivers to spawn. On the Atlantic coast the two most important kinds are shad and alewives, which are also called river herring. The catch of all such fish is very small compared with the yearly catch of more than half a billion pounds of salmon.

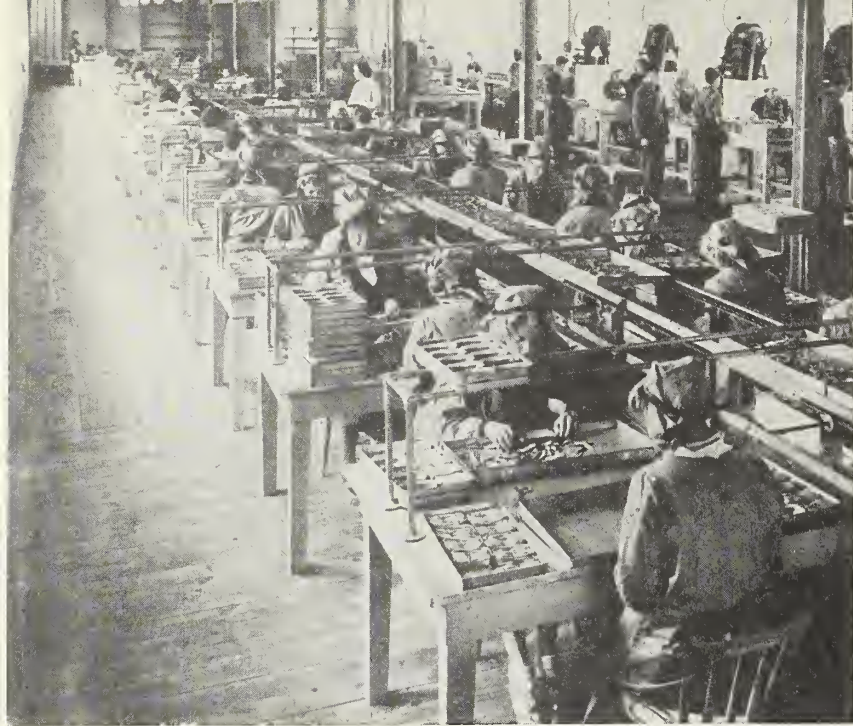
Fishing for surface fish. A few other kinds of fish are long-distance travelers, although they do not go up the rivers. They spend part of their time offshore, but are usually caught near the coast. Offshore they may stay deeper in the water. But when they come close to shore in their yearly migrations they are surface fish.

Most valuable of the surface fish are fish of the herring family. Herring and their relatives, the pilchards, have been called the world's greatest sea resource. It is hard to estimate just how valuable herring are. Meat and animal products are scarce even today in the crowded lands of Asia and in many tropical regions. People cannot raise many animals for themselves. They cannot afford to buy large quantities of meat and dairy products from other regions. But they can eat dried, smoked, and salted herring. Without these cheap fish their diets would be very unsatisfactory.

Herring stay near the surface most of the time because that is where they find their food. Fish get oxygen from water that enters their mouths and passes out through gills at the sides of their heads. Herring and a few other fish have organs called gill rakers that strain plankton from the water before it enters the gills. They usually stay near the surface because plankton is most abundant there.

In the spring and fall herring swim along the shore in dense schools. Fishermen use weirs to catch them. A weir is shaped much like the pound nets described on page 33. It is made by driving poles into the bottom and piling brush between them. Netting may be spread over the brush. The leader from the trap reaches all the way to shore. Herring come to the leader and follow it into the trap through a narrow opening. A mouse would easily find his way out of such a simple trap, but it is beyond the intelligence of a fish.

Along the Pacific coast purse seines are the gear most often used for herring. Many of these are used on the Atlantic coast, too. The purse seine requires a large fishing vessel and at least two small boats. When the fishermen see a school of fish, they lower the seine into the water. It is a long net with floats at the top. At the bottom are iron rings with a rope run through them. An end of the seine is held by the men in one of the small boats. The second boat runs



Courtesy Royal Norwegian Information Services

Packing a famous brand of sardines in a Norwegian cannery.

around the school of fish, carrying the other end of the seine with it. When the fish are enclosed in a circle of net, a power winch pulls in the rope.

The rope runs through all the rings in the bottom of the net. As the rope comes in, it draws the bottom of the net together to form a huge bag—a purse, the fishermen call it. The foolish fish allow the net to be drawn under them. After the seine has been pursed, it is drawn over the side of the large vessel and the fish are taken out.

Of the thousands of tons of herring that are caught, very few are eaten as fresh fish. A small fraction of the catch is canned. Another small fraction is prepared with vinegar and spices as an appetizer. Most of the herring that are to be used as food are prepared in the old-time ways, by pickling, dry salting, and smoking.

Have you ever eaten a sardine sandwich? Those little one-bite fish may have been young herring. Many people think that sardine is the name of a special kind of fish, but it is not. Sardines are young fish of the herring family packed in oil or sauce.

The fish are usually three to five inches long. On the Atlantic coast, especially in Maine and New Brunswick, the sardines canned are young herring. On the Pacific coast, especially in California, young pilchards are canned. Norwegian sardines are herring. Most of the Mediterranean sardines are pilchards.

Fishermen use the same method for catching sardines as for catching the larger herring. Most of them are caught in purse seines and traps of various kinds. Haul seines are used also. These are operated from the shore.

In addition to the sardines prepared as human food, many go into dog and cat food and food for animals on fur farms. Still more go to the fish-reduction

plants. Sardines are oily fish. In the reduction plants the oil is pressed out of the fish. The oil is used in paint, as a raw material in soapmaking, and sometimes as a lubricant. The solid cake that is left is dried and ground. The fish meal is sold as poultry and stock feed and for fertilizer.

Some of the scales go to market, too. Almost anything with a pearly luster has in it a material made from fish scales. The manufacturers of imitation pearls make them look like pearls by painting beads with this material. Fish-scale paint is sometimes used on automobiles. Fish scales also give a pearly look to many plastics.

Mackerel fishing. When the sardine fishermen of Los Angeles cannot find pilchards, they often catch mackerel. They use purse seines for mackerel, as they do for pilchards. Mackerel are also an important catch on the Atlantic coast. Three-fourths of the Atlantic mackerel catch goes to market as fresh or frozen fish. The rest is salted or smoked. Quick-frozen food is about the same as fresh. It tastes the same and can

be prepared in the same way. Freezing is a way of keeping food fresh. Mackerel are marketed either in the round or filleted. A fillet is the meat from one side of a fish, without the bones. A fish in the round is one that is not filleted or split open.

Mackerel are not just American fish. A great many are caught also in the cooler waters of Europe and Asia—in the North Sea, northward along the coasts of Norway, and around the islands of Japan.

Offshore Fishermen

Offshore fishermen need larger boats and stronger gear than the inshore fishermen. They go farther from home than most inshore fishermen and stay away longer. They must have means of keeping the fish

from spoiling during the long trip. Some of their vessels have freezing machinery. On others the fish are packed in ice.

The groundfishes. Groundfishes are caught mainly by offshore fishermen. The name is used for a special group of bottom fishes found in northern waters. The group includes cod, haddock, pollack, hake, rosefish, flounders, and halibut. The map on the next page shows the range of the groundfishes. Most of their range is north of the fiftieth parallel, and it extends all around the Arctic Ocean.

Most of the cod and haddock brought in by New England, Canadian, and Newfoundland fishermen are caught on the banks. The fishing banks lie along the outer edge of the continental shelf. They are in three

British offshore fishermen starting out. The vessel is called a drifter because it is equipped with drift nets which drift at the surface of the water. The floats you see on the deck support the nets.

Courtesy British Information Services





The range of groundfishes, including cod, haddock, and different kinds of flatfishes.

groups. Farthest south are the New England Banks. Of these the largest, Georges Bank, has an area of 22,000 square miles. The New England Banks are fished mainly by New England fishermen, though many Canadians also fish here. A good many New England fishermen go to the Nova Scotia Banks, but not many go to the Grand Banks of Newfoundland. Only the largest and strongest vessels attempt the long trips.

Fishing for cod. Cod, haddock, pollack, whiting, hake, and cusk are all related. Their habits are enough alike so that a description of cod will do for the rest. Cod do not make regular migrations, as herring do, but they travel long distances. Scientists who study fish fasten numbered tags to fish and let them go again. A cod tagged near Iceland was caught later near the coast of Labrador, two thousand miles away.

The banks fishermen developed a special method of fishing with lines. The first ones used hand lines, dropped over the side of the ship. Later they used trawl lines. The fishing schooners carried rowboats, called dories, stacked on their decks. At the fishing ground the dories were placed in the

water. Two fishermen got into each dory. They had a trawl line coiled in the dory. The trawl line was a long line, perhaps a mile in length, with many short lines branching off it. At the end of each short line was a ready-baited hook.

The fishermen chose a good spot for fishing and began to "pay out" the trawl line. The line was weighted so that it would be on the bottom. The ends were held at the top of the water by floats. After perhaps half an hour the fishermen hauled in the line. Beginning at one end, they pulled it up, took off the fish, and rebaited the hooks.

Some trawl lines are still used, and some sailing schooners still go out to the banks. Now, however, most of the banks vessels are large otter trawlers, driven by engines. An otter trawl, you remember, is a big funnel-shaped net that is dragged over the bottom. The otter trawler is the vessel that drags it.

Fishing for flatfishes. Another group of groundfishes are the flounders. Something very strange happens to flounders as they grow up. When they hatch they are perfectly ordinary-looking young fish. They swim in the usual fish position, backs up. They are the same color on both sides and have an eye on each side of the head.

As the young flounder grows, one eye begins to move slowly. It moves right up over the flounder's head and stops beside the other eye. The fish then has two eyes on one side of its head and none on the other. Its mouth, too, twists partly to one side. At the same time the fish begins to tip over. By the time the eye has stopped moving, the fish is swimming on one side. After that it spends most of its time on the bottom, eyeless side down. The underside becomes very pale—white or nearly white. The upper side is bluish or gray or brown, according to the kind of flounder.

Flounders are called flatfish. The name suits them well, for they are thin and their sides are flat. There are many kinds of flatfish. They look much alike, except for

color and size. The different kinds of flatfish have special names—yellowtail, blackback, sole, dab, plaice, and halibut.

Flatfish are found over the whole range of the groundfishes. The same kinds are not caught everywhere, and the different kinds have different habits. Some of the smaller ones, weighing only a fraction of a pound, spend part of the time in shallow bays and inlets, where they are caught by inshore fishermen. The huge halibut may weigh two hundred pounds and usually lives on the outer slopes of the continental shelf.

Halibut were once plentiful on the Atlantic fishing grounds, but now most of the catch comes from the Pacific. They are usually caught with a hook and line. Some of the smaller flatfish are caught on trawl lines, but most of the catch of these fish is made by otter trawlers.

Except for cod, most of the groundfishes go to market as fresh or frozen fish. Some are sold whole and others are filleted. The big halibuts are usually sliced crosswise into steaks. Cod, too, are sold fresh and frozen, but they are also salted, smoked, and dried in various ways. The United States government reports on the fishing industry list ten products made from codfish. The Canadian government lists eighteen.

Some years ago scientists learned about vitamins. People already knew that the oil extracted from cod livers was good for many ailments, but they did not know why. After the discovery of vitamins, they found out that cod-liver oil is rich in vitamins. Now practically all the cod livers are saved for making oil. It was discovered later that vitamin-rich oil can be made from the livers of other fish, too.

In Newfoundland more than a third of the people depend upon fishing for a living, and most of the fish caught are cod. Newfoundland has a sparse population, and so most of its large catch of fish is exported.

Iceland has a large frozen-fish industry. The freezing plants are located near shore. The fishermen clean the fish and pack them

in ice as soon as they are caught. When they have a load, they rush the fish to shore. In the shore plants the fish are washed and are hurried to the freezers. They are frozen solid within a few hours from the time they are pulled from the water.

Over on the other side of the Atlantic, groundfishes are caught along all the shores of northern Europe. British, French, and Dutch fishermen catch a great many. Vast quantities of fish are needed for food in the densely populated region of industrial western Europe. A large part of the catch is sold fresh, but some of the fish are prepared in all the ways they are prepared on our own side of the Atlantic.

No country has gone farther than Norway in using modern methods in its fishing industry. Norwegians fish all along the coast, but some of their best fishing grounds are far away from where most of the people live. One of the best of these is around the Lofoten Islands, far to the north. As along the coast of Labrador, fish are abundant on these grounds only in summer. For hundreds of years Norwegian fishermen have gone to the Lofoten Islands in the spring. For a long time these fishermen just used their best judgment as to when it was time to go. Then they began to use telephones and radio. A few men go ahead to watch for the fish. When the fish appear, the watchers send messages to all the ports along the coast. Hundreds of vessels go chugging northward with their gear. Since World War II the Norwegians have been using radar to locate schools of fish.

From more southern fishing grounds, the Norwegians are sending fish to market by airplane. There is a great demand for fresh fish in the large inland cities of Europe. With airplane service from Norway, the people of these cities can have fish within a day after they are caught.

The Norwegians also have factory ships. A large ship follows the fishing fleets. The fishermen take their catch to the ship instead of making the long trip to port with

their fish. On the factory ship the fish are filleted and frozen. The livers and trimmings go to another ship to be made into oil and meal. Speedy little ships rush the frozen fish to market at once.

Fishermen Far from Home

Most of the valuable fish live near shore, or at least over the continental shelves. A few do not. They are at home in the open ocean, where the depth of the water is measured in miles. Fishermen who would catch them must follow where they go.

The mysterious tuna. Every grocer keeps canned tuna on his shelves. It seems like an ordinary, everyday kind of fish when it is in cans. In the ocean it is a far-traveled stranger. Scientists know almost nothing about the lives of the five kinds of tunas. They do not know where the fish are hatched or where they go. They only know that tunas travel long distances.

Tunas belong to the mackerel family, but their habits are not the habits of the common mackerel. They are caught in every ocean but the Arctic, and are caught by fishermen of every continent.

Japanese and some South Pacific island fishermen dry part of their tuna. With this exception, practically all tuna is canned. There are canneries in New England, California, Washington, and Oregon. There are canneries in Hawaii, Japan, the Philippines, Australia, New Zealand, Chile, Peru, and the Mediterranean countries. In the United States more tuna is canned than any other fish except salmon. The waste from cleaning the fish is made into oil and meal. Livers are saved for their vitamins.

In the United States more tunas are caught by fishermen from southern California than from any other region. They call their vessels tuna clippers. These clippers have Diesel engines. The ships are from eighty to one hundred fifty feet long and carry crews of from ten to nineteen men. The

clippers start out in early summer and are gone about three months. Most of them go southward toward the equator, often more than two thousand miles from home. Some go west as far as the Hawaiian Islands. On the way the fishermen catch small fish for bait. They keep the bait fish alive in tanks.

The fishermen watch for schools of tuna. When they see the fish they throw some of their live bait into the water. Tunas are very greedy. They begin eating the small fish and become so excited that they will try to swallow anything they see.

The clippers have platforms built out over the water. Fishermen fish from these platforms with short bamboo poles. If the fish are large, several men work together, with their poles attached to the same line. No bait is needed—just a hook hidden under white feathers. The clippers have machinery for freezing the fish that are caught.

The romance of whaling. Whales are not fish, though they live in the ocean and are shaped like fish. Fish are cold-blooded animals. Their temperature goes up and down with the water in which they swim. Whales are warm-blooded animals like cats and dogs and horses and bears. Or like yourself. This means that their bodies must always stay at about the same temperature, which is warmer than their surroundings except perhaps on a very hot summer day. Whales do not have fur to keep them warm, as land animals have, or clothes, as you have. Instead, they have a deep layer of fat, called blubber, under their skin. This protects them from the icy waters in which they often swim. Whales are caught mainly for the blubber, which yields a valuable oil when it is boiled down.

There are many kinds of whales. Some are small, but the largest grow to be a hundred feet long. Their weight averages a ton for each foot of length. They are by far the largest and heaviest animals that have ever lived on the earth. Large as they are, whales of this kind have very small

mouths and live mainly on tiny shrimp. Whales of one kind have in their mouths plates of a bony material that strain plankton from the water. Other kinds are able to catch and swallow large fish.

Modern industry requires vast quantities of fats and oils for food, soap, and paint, for softening leather, and as a lubricant. Vegetable oils, animal oils, and fish oil cannot be produced in large enough quantities to meet the need.

As industries grew, whalers began going out into all the oceans. So many whales were caught that it looked as if some of the most valuable kinds might become extinct. The whalers belonged to many nations. If whales were to be saved, all these nations would have to agree to measures protecting them. Such an agreement went into effect in 1935. Whaling is entirely forbidden in

some areas, and in others it is restricted. Certain methods are forbidden, and the number of whales that may be caught each year is limited.

A little whaling is carried on in the North Pacific and in the Arctic Ocean. A few whales are caught farther south in the Pacific, in the Atlantic, and in the Indian Ocean; but large-scale whaling is forbidden in most of these waters. The chief whaling ground of the present day is along the great ice barrier that surrounds Antarctica. Most of the whalers are Norwegians. There are also a few whalers of other nationalities.

Modern whaling vessels are called factory ships. They are huge vessels. Each vessel is accompanied by a little fleet of whale catchers—small, fast, seaworthy ships. In the bow of each whale catcher is mounted a harpoon gun. When the lookout sights

A factory ship where whale oil is extracted. The blubber being peeled off the whale is one foot thick.

AFAPA



a whale, the whale catcher pursues it until it is within range. Then the harpooner fires the harpoon gun. The harpoon has a sharp point and carries a charge of explosive. The charge explodes inside the whale. It kills the whale instantly and releases a gas that keeps the body from sinking. The whale is marked with a buoy, and the catcher goes on for more. At the end of the day it tows the whales to the factory ship.

The factory ship has a wide door in the stern. Inside, a slanting runway leads up to the deck. Power machines drag the body of the whale up to the deck. Machines strip off the blubber. The oil is extracted in pressure boilers, and the rest of the whale is made into animal food and fertilizer.

Look at your globe and measure the distance from Norway to Antaretica. The

whalers go farther from home than any other fishermen. They spend the summer in Antaretica—the Antarctic summer, that is. Then they go back and spend the summer in Norway. Summer along the Antarctic ice barrier is not warm. Huge icebergs float in the ocean and threaten to crush the ships. Fogs hide the dangers. The weather is cold and dreary; but the whalers do have around-the-clock daylight, and the chase is most exciting.

In spite of the great distance, almost halfway around the earth, and all the difficulties, the Norwegians go on building larger and more efficient whaling ships. Other countries, too, plan to carry on more whaling. If this great world resource is properly used, people can have whale oil as long as they need it.

A WORKSHOP ON HUNTING AND FISHING

This Workshop probably has more activities than your class can carry out. As far as possible, choose your activities before you begin the study of the chapter, so that you can be collecting information and materials. Don't be a lone wolf. The class should coöperate in the activities. If you find something you would like to do all by yourself, talk it over with your class. If your fellow students think you could help the class more by doing something else, then let the majority rule. Save your own idea for vacation. In choosing activities, consider the following points: (1) The resources available. Some will be especially suitable for your community. Some will not. (2) The interests of the class. Ask your teacher for suggestions.

Your Community as a Laboratory

The activities suggested in this part of the Workshop will be most useful if they are carried out during the time you are working with the chapter. On page 24 the authors suggest that you find out about wild foods in your own region. You need a record of what you find out. A loose-leaf notebook

is one good way of keeping records. It will have lists, maps, graphs, drawings, descriptions, and, in fact, anything you and your classmates want to put in it.

FOR HUNTERS AND FISHERMEN

1. What wild game animals and fish could you get if you went hunting and fishing near your home? You have probably listed the fish and other animals in your record of wild foods in your community. Now you might add more information to the record book, such as: (a) brief descriptions of the animals and fish; (b) pictures; (c) a map showing where people go for hunting and fishing.

2. What fish and game laws apply to your community? (a) Are there open and closed seasons? If so, what are the dates? (b) Are licenses necessary? How do you get a license? (c) Who enforces the laws?

COMMERCIAL HUNTING

This is for just a few of you. If any commercial hunting and trapping is done in your community, you certainly want to know about it and have it in your records.

1. Find out, if you can: (a) how many commercial hunters and trappers there are in your county; (b) what animals they hunt and trap; (c) where they sell the skins and how much they get for them; (d) whether this is a full-time or a spare-time job.

2. Are there any fur farmers near your home? If so, what animals do they raise?

3. Do sports hunters come to your region? If so, do they help the people of your region to make a living?

COMMERCIAL FISHING

If commercial fishing is one of the industries of your community, you will, of course, make a special study of it. If you have a chance to talk to fishermen, ask them exactly how they do their work, what kind of fish they catch, and how they prepare them for market. Examine their boats and gear. Find out what names they use for their equipment. Learn what their problems are. Ask them why they decided to become fishermen, what they like about their work, and what they do not like.

If there are no commercial fishermen in your community, pay no attention to this activity. Your turn will come later, when you study other industries.

WHAT FISH CAN YOU BUY AND USE?

Here is an activity that every class should carry out. It is a good project for a committee chosen by the class. Find out what kinds of fish and fish products are available in your community. To do this you will need to make a survey of markets and stores. Find out in what forms fish products can be bought in your community, the kinds of fish available, and, if possible, where they came from.

Find out about other sea products too—oils for medicine, fish-oil vitamin capsules, fish meal for poultry or fertilizer, pearl buttons, and any other products that are sold in your community.

Make a collection of recipes for cooking the fish and shellfish that you can buy or catch in your community. You can get recipes from your mother's cookbooks, from magazines and newspapers, and from almost any good cook. If possible, try out at least one of the recipes for yourself.

Test Your Skill and Knowledge

The following tests should come at the end of your study of hunting and fishing. They are not too easy, but you should be able to make a fair score.

MAKE YOURSELF A GRAPH

You have seen a number of graphs in this book. Making a graph of your own is the best way to test your ability to understand graphs. Every graph must start with a table of figures. The table below gives you the figures for fish caught in one year in the ten leading fishing countries.

COUNTRY	BILLIONS OF POUNDS
Japan.....	8
United States, with Alaska.....	4
Soviet Union.....	$3\frac{1}{2}$
China.....	3
Great Britain.....	$2\frac{1}{4}$
Korea.....	$2\frac{1}{4}$
Norway.....	2
Canada.....	$1\frac{1}{4}$
Iceland.....	$\frac{3}{4}$
Netherlands.....	$\frac{1}{2}$

If you like to draw, you may draw a pictorial graph, like the one on page 34. Let each fish stand for a billion pounds of fish. If you prefer, you may make a bar graph. You might let half an inch stand for a billion pounds. Then your top bar will be four inches long and your lowest bar will be a quarter-inch long.

Now you have a graph with ten bars. Check it with the graphs of the rest of the class. For every bar that is the right length you get one point. A perfect score is ten.

On the graph you can see at a glance how countries compare as to the quantity of fish their fishermen catch. That is the main purpose of a graph. When a description of something is very clear, so that we can almost see the object, we say the description is graphic. We mean that it is almost as clear as a graph.

There are other things you can do with a graph. Compare your graph with the one on page 31. Are the countries with the largest proportion of fishermen always the largest fish producers? Your answer sets up a problem. Why not? Think about the

size of the population, and the answer is easy. You can find populations in the table on page 349.

If no fish were exported, how much fish would there be for each person in each of the ten leading fishing countries? Do you think you eat your share of fish?

FISHING GEAR

You do not need to learn the names of different types of fishing gear unless you wish to. If you do want to learn them, try this test. There are five little pictures below. They show the five kinds of gear that catch the most fish in the United States.

Match the pictures with the names in the following list: (a) trawl line, (b) gill net, (c) purse seine, (d) otter trawl, (e) pound net.

WORDS YOU SHOULD KNOW

In this chapter you have met five important words that you may not have known before. These words are: culture, habitat, instinct, primitive, range. You should know them so well that you can use them yourself.

In each of the groups below, two sentences are right and two are wrong. You must find both correct sentences to prove that you understand how the word is used. If you get them both, you have earned ten points. Getting one is not half so good as getting two. It is worth one point.

1. Culture

- All the ways of living of a people are part of their culture.
- Before they met people from other parts of the world, Eskimos were living in an Old Stone Age culture.
- Only primitive people have a culture.
- The Bushmen of the Kalahari Desert have no culture.

2. Habitat

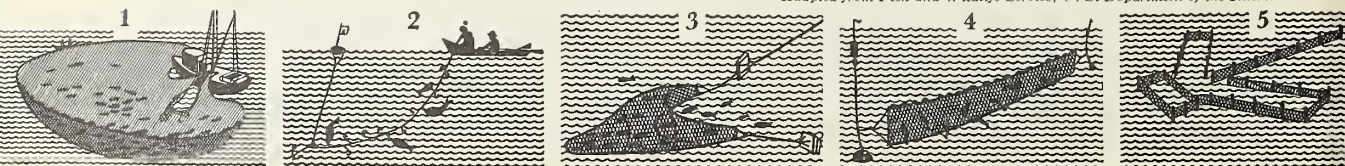
- Salmon have the habitat of swimming up rivers to spawn.
- Fishermen must go into the habitat of a fish to catch it.

- The habitat of any animal must include food that it can eat.
 - The sea bottom is the habitat of groundfishes.
- ### 3. Instinct
- Instinct leads a flatfish to rest on the sea bottom eyeless side down.
 - Guided by instinct, mackerel swim northward in the spring.
 - Fishermen know by instinct where fish are likely to be found.
 - Plankton is made up of microscopic plants and instincts.
- ### 4. Primitive
- The men who go out on otter trawlers are primitive fishermen.
 - Hunting for food is a primitive way of making a living.
 - You can become primitive by going fishing.
 - Most primitive people of today live in regions of the world that are poor in resources.
- ### 5. Range
- Oyster fishermen have added to the range of the Japanese oyster by planting it on the western coast of North America.
 - The range of any kind of fish is limited by the distance that fish of that kind can swim easily.
 - The term "range" means the area in which a fish is caught.
 - The range of any animal is the whole region in which it lives.

ADDITIONAL INFORMATION

The United States Department of the Interior, Fish and Wildlife Service, Washington, D.C., has booklets that you might find helpful in your study. They can supply you with booklets on cooking fish, on the fish of each fishing region, on various kinds of fish, on methods of fishing, and on fish and game laws. If you wish to get any of these materials, write to Washington and ask for them as soon as you begin the study of hunting and fishing.

Adapted from Fish and Wildlife Service, U. S. Department of the Interior





Farmers and Herdsmen

GET ACQUAINTED WITH PLANTS

Have you ever raised a plant from seed? Some of you who read this book are sons and daughters of farmers. You have helped your fathers farm and perhaps have cultivated a field or garden of your own. Even some of you who live in cities may have helped with a garden. Others may never have watched plants grow from seed.

Wouldn't you like to watch something grow while you study this chapter? Your class may be able to plant a garden out of doors, but that depends upon where you live and the time of year. If you are reading this in the midst of a northern winter, you will have to do your gardening indoors. Find out what crops are grown in your own region and try as many of them as you can, even if you have to grow them in flowerpots and boxes indoors in your schoolroom. Plant a

few seeds of crop plants grown in other regions, too, if you can get them.

If you are very ambitious, you may try some experiments with your plants. Plant seeds of the same kind at different depths in the soil; then time them to see which come up first. Put some of the plants where they get more sunlight than others of the same kind. Use sandy soil for some and dark, heavy soil for others. Try different quantities of water. If you can get fertilizers, you may experiment with them, too.

It will interest you to see how seeds sprout. You might plant fifteen or twenty seeds of the same kind for your research on seed growth. Dig up one seed each day to see how much it has grown.

Scientists keep careful records of their experiments. You will need to do that, too.

Mark the pots or boxes so that you will know what treatment each of them has received. Then keep a record of the results. No matter how much you learn from your plant experiments, it will be only a very small part of what a farmer must know to be successful in his work.

While you are finding out what crops grow in your region, be sure to look over the Work-

shop, beginning on page 113. For the Workshop you will need other information about farming in your own region. You will be able to get some of this information while you are inquiring about crops. Then you will have it when you need it. You will also want to begin some of the Workshop activities at once, instead of waiting until you have finished reading this chapter.

HOW PEOPLE LEARNED TO FARM

Everything we have comes from the earth, including our food. Plants can take food directly from soil, air, and water, but we cannot. We must depend upon the plants to do it for us. We also depend upon plants for most of our clothes and many of our industrial raw materials.

A sugar beet can do something we cannot do. It can manufacture sugar from air and water. Sugar is made up of carbon, hydrogen, and oxygen. Water is a combination of hydrogen and oxygen. In the air is a gas called carbon dioxide, made up of carbon and oxygen. The plant draws water from the soil. Through tiny pores in the leaves it takes in carbon dioxide from the air. When sunlight falls on the green leaves, the carbon, oxygen, and hydrogen combine to form sugar. Then the sugar, dissolved in water, moves downward through the stems and is stored in the large root of the plant.

All green plants make sugar from air and water, but they do not all store much of it as sugar. They go on, changing it to other substances, such as starch and oil. Other materials drawn from the soil are added. We get these necessary food substances by eating parts of plants or the flesh of animals that have eaten plants.

You cannot watch the process of sugar making in your plants, but you can prove for yourself that light is necessary. Try keeping one of your plants in a dark place. Some plants need more light than others, but no green plant can live in the dark.

The First Farmers

People have always depended upon plants just as we do, but they have not always known how to grow plants. Let us look back again at the people of long ago. We left them still Old Stone Age hunters, fishers, and collectors. They got all their food and the materials for clothing from wild plants and animals. Finally some of them learned how to grow plants and keep domestic animals.

Who were the first farmers? Farming was one of the great inventions of all time, but we do not know who made the invention. We are not even sure just where it was made, but scientists think it was in southwestern Asia. Or it might possibly have been Egypt. The first farmers we know about lived in the region that stretches from the Indus to the Nile. The oldest cultivated plants were wild plants of the eastern Mediterranean region. The first domesticated animals were wild animals of this region. Dogs and pigs are the only exceptions. Dogs were probably domesticated earlier—in the Old Stone Age.

The first domesticated plants were probably barley and wheat. It is likely that women had been collecting the plump seeds of these plants for a long time. No doubt they had already learned that the seeds could be crushed, mixed with water, and baked into flat, crisp cakes before the fire.

People must have known that plants grew from seeds. They could hardly have failed

to notice that. Someone finally thought of scattering seeds on the ground. This was probably a woman who wanted the plants to grow where they had not grown naturally.

Scientists think the very first farmers lived in one of the great river valleys—the Nile or the Tigris-Euphrates. There each year the flood waters moisten the earth and bring a new layer of soft, fertile soil. The very earliest farmers we know about irrigated the land. It may be that simple irrigation came before real farming. Perhaps the population was increasing and food was getting hard to find.

Someone may have reasoned like this: “It is easy to see that plants grow only where the earth is moist. We could dig ditches and bring water from the river to moisten the dry land. But no plants grow there now, and so there are no seeds. If we bring water, we must also bring seeds.”

Something like that may have happened. We do not know. However farming began, it was very simple at first. Farmers had a great many more discoveries and inventions to make. Still, those first farmers had discovered more than farming. They had learned that they could change their environment. Having learned this, they began to make so many discoveries and inventions that they soon had a whole new culture.

Scientists call the culture of the first farmers New Stone Age culture. It was still Stone Age because tools and weapons were made of stone, but it was much more complex than the culture of the Old Stone Age. Complex is the opposite of simple.

Farming gave the people of the New Stone Age a secure food supply. They could stay in one place instead of wandering about in search of something to eat. They could also live in larger groups. When a number of families could live together in one place, the early farmers learned to build houses and



Ewing Galloway

In many places human hands still harvest grain, as they did in the time of the first farmers. This field is in India.

grouped them in villages. Soon they made other inventions. You will read more about them later.

The first herdsmen. In the beginning, the river-valley farmers probably had no domestic animals. Apparently animals were domesticated about the time plants were, but not by the same people. Scientists think that sheep, goats, cattle, and probably donkeys and camels were domesticated by people who lived on the dry grasslands and deserts of southwestern Asia.

The words “farming” and “agriculture” may be used for the keeping of animals as well as for the growing of plants. It is correct to call the early animal-keepers farmers, but we usually call them herdsmen. This term is used for people who keep herds of animals on open grasslands. Those early herdsmen were nomadic herdsmen; that is, they lived in tents and moved with their animals from place to place.

Before long the river-valley farmers got some of the domestic animals. They kept the animals on their farms and pastured them near by. Soon they learned that some of the animals could be trained to work for them. Cattle could pull plows and donkeys could carry loads on their backs. Either farmers or herdsmen discovered that some of their

domestic animals could be milked, and that butter and cheese could be made from milk.

Spread of the new culture. From the eastern end of the Mediterranean, the knowledge of farming spread to the east across Asia, to the north and west across Europe, to the south and west in Africa. Animals and seeds were passed on from people to people. When people of western Europe learned to farm, they grew plants and farm animals that were native to western Asia, not to Europe. There is one exception. They probably domesticated pigs for themselves. Pigs are forest animals, not animals of the grasslands. Apparently people in western Europe domesticated the wild pigs of their own forests.

The plants and animals of southwestern Asia traveled a long way. In very early times they were grown from the British Isles to China. It is surprising that they were able to make themselves at home in regions with so many differences in climate.

In other parts of the world people domesticated plants and animals of their own regions. In southeastern Asia, for example, rice took the place of wheat and barley.

The spread of wheat farming in ancient times.



Water buffaloes took the place of cattle. Most scientists think that the people of south-eastern Asia had probably heard about farming. They were not far from the early farmers of the Indus Valley. But they had to find their own crops and work out their own techniques. That word *techniques* is a good one for you to learn. It means ways of work, the methods of growing a crop or of making something.

The first American farmers. If farming was invented twice, then the Indians were the second inventors. Some anthropologists think they brought a knowledge of farming with them when they migrated from Asia to America. Others think they invented it for themselves. Whichever is true, the Indians began to farm a very long time ago, and all their crop plants were native to America.

Corn is probably the oldest crop of the Indians. Ears of corn and pottery shaped like ears of corn have been found in very ancient Indian graves. Scientists agree that corn was domesticated first somewhere between Mexico and Peru. It was therefore a tropical or subtropical plant. When Europeans came to America, they found the Indians growing it all the way from New England and southern Canada almost to the southern end of South America. There were many varieties. The Indians had sweet corn, popcorn, and a great many kinds of ordinary corn. Corn may be yellow, white, red, almost brown, a grayish blue, or variegated. The kernels may be hard or soft, large or small. There are kinds with tall stalks and kinds with short stalks. Some need a long time to ripen and others will ripen in a short time. Nearly every tribe had its own varieties—several of them for different uses. A very long time must have passed before so many kinds of corn were developed.

Corn was not the only crop grown by the Indians. Almost everywhere they raised beans, squashes, and pumpkins. From a little north of Mexico southward to Peru there was a region with a much greater



U. S. Indian Service

Corn being ground by present-day Indians in America. Corn, domesticated by early Indians, is just one of many American plants that now make food more interesting for almost everyone in the world.

variety of crops. In this region lived the Aztecs of central Mexico, the Mayas of southern Mexico and Central America, and the Incas of the South American highlands. These peoples and some of their neighbors had a more complex culture than any other Indians. They were excellent farmers. Where the land was dry, they built irrigation works. The Incas terraced the steep slopes of their mountain land. All cultivated the ground carefully. They worked with hand tools. Like other Indians, they had no plow animals, although some of them did have domestic animals.

The Inca Indians had domestic alpacas and llamas. They used alpacas for meat and for wool. A llama will carry a load on his back, if the load does not weigh more than about a hundred pounds. If it weighs more, he will not move. Llamas do not pull anything. If the Indians had invented a plow, they would have had no animal to pull it.

Indians had no wheeled vehicles, either—not even the most simple cart.

With food plants the story was different. Almost a third of the farm land in the United States now is used for native American crops. These are crops that Europeans did not have until after America was discovered. They did not grow wild anywhere in the world except in the Americas. Indians had found them and domesticated them.

You know about corn. Undoubtedly it was developed in the Mexico-to-Peru region. Potatoes were apparently domesticated on the high plateaus of the Andes. Plant scientists think so for two reasons. Wild potatoes grow there, and the people cultivate a great many different varieties. There are white potatoes, yellow potatoes, red potatoes, and potatoes that are purple inside. There are small ones and large ones, rough ones and smooth ones. There is one kind that is not good to eat until it has been frozen. Beans

of various kinds, pumpkins, squashes, peppers, tomatoes, and peanuts were probably grown first in the tropical highlands by the Indians. Sweet potatoes are an Indian vegetable, too, but so far as we know they are native to tropical lowlands rather than to tropical highlands.

Nearly all the people of the world have reason to be grateful to the Indians. The early Portuguese traders took some of the American plants to Africa. Corn is now grown by the Africans over much of the continent. In parts of Africa peanuts and sweet potatoes are grown in large quantities, too. In southern and eastern Asia, also, corn, peanuts, and sweet potatoes are grown by millions of farmers. Cassava is another plant of tropical lowlands that has spread around the world from America.

Nomadic Herdsmen Today

Probably every kind of culture that ever existed can still be found somewhere. This is true even of hunting, fishing, and collecting, the simplest and most primitive of all cultures. You remember what the word "primitive" means, of course. It describes something that has not changed much from the way it was in the beginning.

We cannot go back to early times to watch the first herdsmen and farmers at work, but we can see how primitive herdsmen and farmers of today do their work. Methods are much the same as those of early times. Not quite the same, of course. Nomadic herding and primitive farming go on today only in lands of poor resources. People in richer lands have worked out more efficient techniques. Early herdsmen and farmers used better land than is available for primitive herdsmen and farmers today.

The land of the nomads. Hunting and collecting are the simplest ways of getting a living from the earth. Nomadic herding is next simplest. Turn to the map on pages 370-371 and find the great region of desert

vegetation extending from western Africa to eastern Asia. This, roughly, is the land of the nomadic herdsmen. The area is huge. It is said to be about one-tenth of the land surface of the earth.

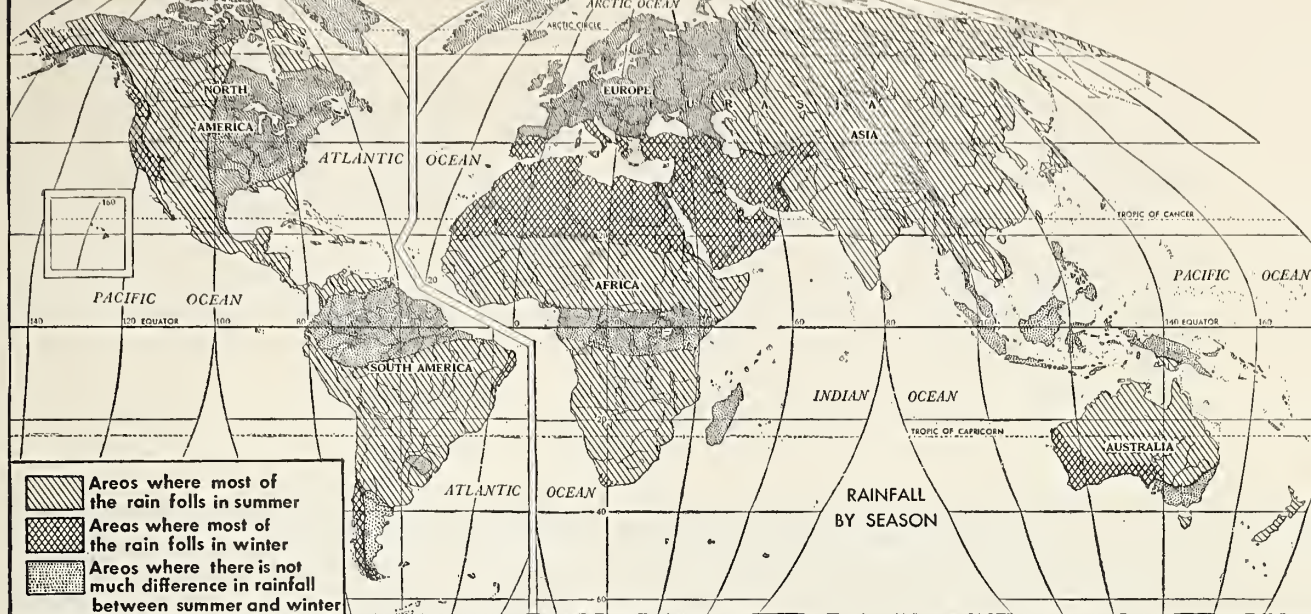
You will want to see what you can find out about this region from the maps. First the population map, pages 372-373. Within the region there are great differences in population. Quite large areas have no people at all. These are the real deserts. Rain almost never falls, and no one lives there. In a few places the population is dense—more than 150 people to the square mile, and even, in places, more than 250. Most of these areas are irrigated.

Now the rainfall map on pages 364-365. No part of the region has more than 20 inches of rain in a year. Most of it has less than 10 inches. The areas with more rain are highlands. You can check this with the world map, pages 362-363, or the maps of Asia and Africa, pages 388-391.

This great expanse of land is not all alike by any means. It is alike in having little rain, scanty vegetation, and few people. In other ways it can be divided into a number of regions. You have studied these regions in your early years of geography. Probably you have learned something about them in history, too. You do not remember everything you learned. No one ever does. But this book does not have space to tell you everything all over again. Probably you can borrow textbooks from another grade now and then to do a little reviewing as you think you need it.

At the top of the next page is a map that shows the *seasonal distribution* of rainfall. It does not tell you how much rain falls in a year. For that you need the map on pages 364-365. It tells you only whether most of the rain falls in winter or in summer, or whether there is rain the year round.

You see that the western part of the great dry area has most of its scanty rainfall in winter. It is the outer fringe of the region of Mediterranean climate. The winds that



Seasonal distribution of rainfall over the land areas of the earth.

bring rain to the Mediterranean coasts bring a few showers to the desert also.

The eastern end of the dry area gets its rain from the monsoon winds of eastern Asia. The winter monsoon, as you know, blows outward from central Asia. It is very dry. The summer monsoon winds blow toward central Asia from the Indian and Pacific oceans. They bring heavy rains to south-eastern Asia in the summer. They have lost most of their moisture before they reach central Asia, but they bring a little rain.

Growing season varies greatly. Look at the map on pages 366-367. Within the herding region there is every possible variation in length, from the 2-to-3-month growing season on the high plateaus of central Asia to the year-round growing season of Arabia and North Africa.

The Bedouins. The Bedouins of Arabia and the Sahara are among the best known of the nomadic herdsman. We might start with them because you have probably studied them before. They live in tents. They ride one-humped camels or handsome white horses. They wear long, loose woolen robes to keep out the heat. These things are what most people know about Bedouins, and it all seems very romantic. Of course, Bedouins

do not seem romantic to themselves. They are just people working hard to make a living in a land of very poor resources.

No, the Bedouins' life is not easy. The men spend their days watching their flocks of sheep and goats. The desert sun scorches them by day. Nights are cold, and the Bedouins are chilled by the sudden drop in temperature. Animals stray away and must be found. The herds must be protected from wild animals. Sheep, goats, and camels must be sheared at the proper seasons. Animals must be killed and dressed, too, for meat is an important part of the Bedouin diet. The hides and skins must be cured, so that they can be sold or used.

Then there is always the need to make sure of water and grass for the animals. The animals need to drink every day—even the camels. In an emergency, on a journey, camels can get along for several days without water. They cannot live without water nearly so long as most people think they can.

Bedouins cannot often drive their flocks and herds to a river for a drink. After a rain there may be a shallow pond in a depression; but much of the time water must be dipped from a well in a leather bucket. Can you imagine dropping a bucket into a well, pulling it up by a rope, pouring it out, over and

over and over again, until several hundred thirsty animals have had a drink? It is very hard work.

Sooner or later there comes a time when the well is dry or the grass is eaten up. The Bedouins do not just wait until this has happened and then wander away looking for a new grazing ground. The young men have

been out scouting for rain. Rain means grass and drinking water.

In the Sahara and Arabia rain comes in small, short showers. Scientists call the rainfall *unreliable*, as well as scanty. They mean that no one can count on the rain. A place may have a number of good showers one year and none at all the next.

Nomadic herdsmen.

LIFE Photograph by David D. Duncan © TIME, Inc.



The nomads must find grass and water. Then they must get their animals and their families safely to the new grazing ground. If more than one day is needed for the journey, they must plan the route carefully. Animals and people must eat and drink on the way. It may be necessary to go a long distance around to find a little grass and water for each day.

The rainfall is seasonal. What little there is falls in winter. The herdsmen can expect none at all in summer. Many of them then move toward the edges of the desert. In Africa the southern edge of the desert gets a little rain in summer. Summer is the equatorial rainy season. The edge of the desert gets a little of this rain. Some nomads go to the edges of oases, or to highlands where there is a little rain.

Bedouin women work hard. A usual meal is mutton, rice, fruit, and coffee. First there must be a fire, and for a fire there must be fuel. The desert has no gas mains or electric cookers. It has no coal dealers and no wood lots. You find your own fuel, if you are a Bedouin woman, and you don't find much. You find a dead plant, too dry even for a camel to eat. You dig up a withered root. You gather the dried droppings of the animals. Then you build a tiny fire in a hole in the ground. Over this little fire you must cook a huge quantity of rice and boil or roast the meat.

In a corner of the tent there is a bag of green coffee beans. You have to roast a few, then pound them and make the coffee over the little fire. The fruit is easy. There is a bag of dried dates bought the last time your tribe visited an oasis.

A Bedouin woman does not have to give the baby a bath every morning or do the laundry on Mondays. She does not even have to wash the dishes after each meal. Being clean is a luxury in the desert. It cannot be enjoyed every day—only when there is an unusually good supply of water.

Bedouin women make all the clothes for their families. Now and then they may buy

cloth in an oasis market, but usually they start with a bundle of wool just as it comes off the sheep. They spin it into yarn with hand spindles and weave the yarn into cloth on hand looms. All that comes before the sewing. No wonder Bedouins often wear ragged clothes!

Spinning and weaving do not end with the family clothing. The women must weave heavy camel's-hair cloth for tents, warm woolen blankets for the cold desert nights, cloth for saddle blankets and for rugs and cushions to take the place of furniture.

Every move means taking down the tents. The tents and all the family possessions must be made into packs for camels and donkeys. At the end of the journey everything has to be unpacked and set up again.

The women do the milking, too. They do not milk just the cows. Many of them have no cows. They milk sheep, goats, and camels. Morning and evening the men bring the milk animals to the tents and tie them in long rows. The women milk them. They make a large part of the milk into butter and cheese, which is not an easy task with the simple equipment they have.

If you saw a Bedouin scrubbed clean and dressed in European clothes, you would not know him from a European. He is a Caucasian. He differs from a European only in his culture. The difference in his culture is due partly to a different historical background, partly to the necessity of making a living with different resources.

The Mongols. Over toward the other end of the nomadic herding region live the Mongols. A Mongol dressed in European clothes would still not look like a European. Dressed in Chinese clothes he might easily be mistaken for a Chinese. He is a Mongolian. In fact, the Mongolian race was named for the Mongols. In spite of the difference in race, he is culturally much more like the Bedouins than he is like the Chinese. His culture resembles Bedouin culture because he must make a living in the same way.

Central Asia is the home of the Mongols. There are areas like the drier parts of the Sahara, but most of central Asia is arid grassland. It differs from the more southern deserts in having cold winters. Because of the high elevation, most of it has cool summers. There may be a little snow in winter, but most of the Mongol region gets the larger part of its moisture in summer. There is enough rain for a little farming in places.

A little rain goes farther in central Asia than in the Sahara and Arabia. It will support more plant life because the water does not evaporate so fast. You probably know that the warmer the air, the more water it can absorb. Warm air, therefore, dries up the moisture after a rain faster than cool air.

Before everything else, the Mongols are horsemen. They keep large herds of their sturdy, tough little horses. They learn to ride horses almost as soon as they can walk. They have camels—two-humped Bactrian camels, not the one-humped dromedaries of the Bedouins. Bedouins ride their camels; Mongols use theirs mostly as pack animals.

The Mongols depend mainly on sheep for a living. They keep fewer goats than the Bedouins, but more cattle. Like the Bedouins, they milk their animals and make butter and cheese. They also drink large quantities of sour milk. Their favorite drink is a combination of sour milk, tea, butter, and salt. They drink it hot.

The Mongols live in tents that are very different from the Bedouin tents. The chief purpose of a Bedouin tent is to keep the Bedouins cool by sheltering them from the sun. It is wide-spreading and airy. The chief purpose of a Mongol tent is to keep the Mongols warm. It is built more solidly and of warmer materials.

The Mongol tent is called a yurt. It is circular and is covered with heavy felt. Felt is made of wool or other animal fibers, but it is not a woven fabric. The fibers are matted together, making a very solid, compact material. It keeps out the icy winds that blow across the high plateaus.

The clothing worn by the Mongols is of wool or sheepskin. Instead of the loose robes of the Bedouins, they wear heavy, closely fitted clothes for warmth.

Mongol women have to do the same work as Bedouin women. The Mongol women probably work even a little harder, because their families need warmer clothes and more of them.

The men have much the same problems as Bedouin herdsmen. Most of them have a little easier time finding pasture; but they have other problems of their own. Their special problems have to do with cold winters and a short growing season. In winter the grass is dry and brown. Animals can still eat it if it is not covered deeply with snow. When deep snows do come, the animals must be moved or many will be lost.

Conditions differ over the vast area of central Asia. Tribes have different customs according to the region in which they live. Most of them, though, make long migrations between winter and summer pastures. Some travel hundreds of miles, north and south. They do not need to make the many small shower-chasing moves of the Bedouins.

The nomads have followed their migration routes for hundreds, perhaps thousands, of years. They know how to plan their travel so that they are always going in the right direction and still have grass and water for every stop. Somewhere along the way, where there is enough rain, they may plant a little barley. Barley does not need much moisture, and it ripens quickly. On the way back, the nomads stop to harvest the crop, if there is any. They do not expect much of a harvest.

Other Mongols have summer pastures in the highlands and winter pastures on lower plains or in valleys. Their trips may be comparatively short. If their valley is a good one, they may not be nomads in the winter. They may even live in log cabins or in huts of sod and earth. They may plant a little grain, and some of the old people may stay in the valley to care for it.

Bedouins and Mongols are not the only nomadic herdsmen, although they are the largest groups. The map on page 53 shows regions of nomadic herdsmen even in the Far North. Those are the lands of the Lapps and other reindeer herdsmen. You have learned about them in your earlier study of geography. They are few in number compared with the herdsmen of Africa and Asia.

Some facts to remember. The work of the nomadic herdsmen is much the same everywhere. The pattern of their culture is largely set by the environment. In the next paragraph there are a few facts about nomadic herdsmen that will be worth your while to learn. They are the kind of facts called *generalizations*.

People can use only the resources they have. Some environments have many different resources. People who live in such environments have many choices of occupation. In poor environments there are few choices. Except on the oases, people who live on the arid lands of Eurasia and Africa have only one resource, the scanty natural vegetation. For most of them there is only one possible occupation. They can make a living only by keeping animals that graze on the natural vegetation. To make a living, a family needs many grazing animals; but it is not possible for so many animals to live on any one spot for long. There is not enough grass. Most of the grass is too short to be cut for hay and brought to the animals. Therefore the animals must be taken to the grass, and the people must go with them. Thus they become nomadic herdsmen. Many other aspects of their culture follow naturally—the movable homes, the scanty belongings, the use of animal products for food and clothing.

Primitive Farmers Today

Both herding and farming probably began in southwestern Asia. You have seen that herdsmen using primitive techniques still live in the same region. To find the most primi-

tive farmers, you will have to go to other parts of the earth. Before you wander away in search of them, think for a moment of the problems farmers must solve.

Farmers have many problems. One of the most important is soil fertility. A fertile soil is one that is well supplied with available plant foods. Soils can go on producing natural vegetation for thousands of years without becoming less fertile. Plants draw food from the soil. They build up other foods from air and water and store them in their leaves, stems, and roots. In time the plants die and decay. Then the plant foods go back to the soil.

A farmer harvests his crop and carries it away from the field. Year after year his plants draw food from the soil. Except for the roots in the ground or a little stubble, nothing goes back. Each year the soil becomes less fertile.

In other ways farming cuts down the natural fertility of the soil. In nature plants crowd together closely, and many kinds of plants grow in the same area. These plants do not all take the same plant foods from the soil. Where a wild morning glory has grown one year, a sunflower may grow next year.

A farmer plants one kind of plant over a whole field. He wants to plant the same thing next year and the next year and the next. Year after year the same plant foods are taken from the soil.

A cultivated field, then, loses its fertility by having its products harvested and carried away. It loses fertility by having only one kind of plant growing in it.

It loses fertility in another way. Most of the fertility is in the topsoil. That means just what it sounds like—the top layer of the soil. Without a solid cover of plants to protect it, the topsoil washes away. During every rain some of it is lost. This process, as you probably know, is called erosion.

The early river-valley farmers had comparatively few problems. Floods brought a new layer of fertile soil each year. The floods killed many weed seeds, leaving clean,

bare soil for the farmer to use. Soon farming spread out to lands not so favorable for farming. Then trouble began. After a few years the crops decreased. A few years more and the crops were so small that they were not worth the work of growing them. No records are left to tell us that this happened in early times, but it must have happened. Land will not go on producing crops unless something is done to keep it fertile.

The primitive farmers found an answer to the problem. It was not a bad answer, as long as the world was full of unfarmed land. The farmers did not know why their land had become unproductive. They probably thought the soil was tired. Whatever they thought, they simply moved on to new land. Their kind of farming has a name. It is called shifting cultivation. There are still shifting cultivators in the world.

Farmers who move their farms. The most primitive farmers in the world today are the shifting cultivators. Like other primitive techniques, shifting cultivation has lasted only in regions with resources that are poor or hard to use, or in small areas that have little contact with the rest of the world. It will not support a dense population. It is a wasteful method of using the land and may spoil it for better techniques.

To find shifting cultivation, you would have to go to out-of-the-way parts of the earth. It is the commonest kind of farming in the high valleys of New Guinea. There are shifting cultivators in other parts of Indonesia, in southeastern Asia, in Africa, and in the equatorial forests of South America. In all these areas there are also other people who are not shifting cultivators. You will learn about them later.

How shifting cultivators work. Imagine that, from somewhere above the treetops, you can watch a village of shifting cultivators settling down in a new location. In a small clearing beside a stream there is a newly built village of one-room houses. Some are

not yet finished and show the bamboo framework. Others are completely covered with palm leaves. In the open space in the center of the village several women are cooking. They drop roots and grain sparingly into their kettles, for they have only the food that they have been able to carry on their backs. With wild foods, it will have to last until harvest time.

The men are out in the forest. The head man and the village council, made up of the older men, are dividing up the land so that each family will have a farm. They try to be fair. Every family in the village must be able to make a living. Large families are given more land than small families.

After the land has been divided, the men go off to their own sections. Each man has a long, strong knife. You have never heard such hacking and chopping as begins now. On each little plot the underbrush goes down. Vines, bushes, small trees, and green plants are all cut away. A series of especially loud whacks means that a man is girdling a large tree. He cuts through the bark all around, but he does not attempt to chop the tree down. He could hardly do that with his knife. Girdling will kill the tree. The farmer does not girdle all the trees, for he wants some to go on growing.

When the farmers have cut everything that they wish to cut, they leave the land for a while. There is no danger of rain, for this is the dry season. The hot sun beats down. Soon the brush and small plants are dry. The leaves wither on the girdled trees.

Then the men set fire to the underbrush. Great billowing clouds of smoke go up. Flames crackle. There is a pop like a fire-cracker when the heat strikes wood that is still moist. The fire burns fiercely, but it stops when it reaches the damp green wall of uncut forest.

The fire leaves the soil covered with a thin layer of ashes. Some girdled trees are still standing, but the leaves have burned off, and the trunks are charred and blackened. Other trunks have fallen. The half-burned

trunks and limbs lie tangled on the ground. The ungirdled trees are scorched but not killed. They will grow new leaves and protect the garden from the blazing sun.

To you the land looks as if it needs much more work before it will be ready for planting. To the villagers it looks fine just as it is. Why clear away the logs and brush? They cover only a small part of the ground, and they will make the soil richer as they decay. Why plow or hoe or spade? There are no weeds. The soil is soft, and the richest part is the surface where the ashes are.

Planting begins at the start of the rainy season. The planting tool is as simple as a tool can be.

Tools like it were probably used by the first farmers. It is just a pointed stick.

The men go over the fields, jabbing the planting sticks into the soft ground. The women follow them, dropping seeds into the holes. After dropping the seeds, a woman covers the hole with a scrape of her foot. The seeds are grain; but the kind of grain depends upon the location of the field and what the people like best. In southeastern Asia there is probably upland rice, which does not need to be flooded. It does not produce so much grain as lowland rice, but it is the only kind these people can grow on their hill land. They probably plant corn and millet, too. The farmer does not have a cornfield and a rice field and a millet field. He has a corn-rice-and-millet field, with a clump of rice or millet here and a few stalks of corn there.

Other plants have been growing in a seedbed. These plants will produce root crops—cassava, sweet potatoes, and yams. They, too, go into the same field. Now it is a rice-corn-millet-cassava-yam-and-sweet potato field with a few banana plants also.

Then for a while only the children have work to do on the farm. Night and day,



U. S. Office of Foreign Agricultural Relations

Cassava, pineapple, banana, and other food plants are mingled together in this primitive garden in Central America. The garden was planted in a clearing in the forest.

until the seeds sprout, children must stay in the fields. Their job is driving away birds. After the seeds have sprouted and the birds cannot eat them, no one pays any attention to the crops for a time. The men go hunting and fishing. The women go out to look for wild fruits and roots. When the first grains begin to ripen, the children go back. It is time to watch for birds again.

The farmers pick the ears of corn and carry them to granaries in the village. They use a sickle to cut off the heads of rice and millet. The grain is not threshed. The women will beat the grain out of a few heads each day as they need it.

The root crops are still growing, but some of the roots are ready to use. A woman digs out a root, fills in the hole, and leaves the plant to go on growing. Village mothers do not send their small children to get a nice big yam for dinner. A yam or a cassava root may weigh fifty or sixty pounds. Many roots are gathered when they are smaller, of course. The root called a yam in the United States is a kind of sweet potato. The real yam is a different plant.

A year passes and planting time is coming again. This time there has been no forest to

clear, but there is weeding to do. The fast-growing vegetation has sprung up again. Tree roots have sent up sprouts. Plants have grown from seeds. These are not much trouble. Big knives slash them down quickly. The real problem is grass. Coarse, tough, wiry grass has grown up in clumps. Hard work with a hoe is needed before planting and while the crops are growing.

For the third year's crop the men clear new land. They do not need to move the village, but they clear another section of forest near it. During this season people go back to the old garden now and then, for the cassava plants are still producing roots. There are ripe bananas, too.

Years pass. Trees have sprung up from the old roots and stumps. Others have grown from seeds. A new forest of vigorous, fast-growing trees has taken the place of the fields. The grass and most of the weeds

A village built by shifting cultivators in the forests of Java. The neatness of the garden and houses shows that this village is new.

Rathenau from Piz



have died out because they cannot live in the dense shade of this new forest.

Every two years the village people have cleared a piece of forest. On each abandoned patch, new forest trees are beginning to grow. They are in different stages of growth according to the length of time since the land was cleared.

Now some of the village people are beginning to complain. This year's fields are five miles away. How would you like to walk five miles to work and five miles home again? Or, if you were a woman, how would you like to carry for five miles a fifty-pound yam, a cluster of bananas, a bag full of beans, a few tomatoes, a hoe, a digging stick, and a baby? Maybe you would rather not carry so much at once, but if you didn't you would just have to make another trip. And of course you probably would have to carry the baby every time. There would be nothing else to do with him.

Yes, it is time to move the village. The houses are in bad repair and are very dirty. Then, too, weeds are coming up in the wide street and even under the houses, where the pigs and chickens live.

Some time, perhaps thirty or forty years from now, the shifting cultivators will shift back to this place. They will have lived in several places in the meantime, but they think of themselves as making up the same village all the while. On the next round, more land will have to be cleared, for the population is growing. More people must be fed. The next circle of the village lands will be made in fewer years because each clearing is larger. A time will come when the people must return before the forest is fully restored. Then the land will be less productive, and the people will have to work harder to keep out the weeds. Sooner or later the old shifting cultivation will have to be given up. The people will have to learn new techniques of farming; but that time still seems a long, long way off.

In the meantime, while the population is still sparse, the people have plenty to eat.

Shifting cultivation is a satisfactory way to make a living, for people whose *standard of living* is low. Do you know what a standard of living is? It is the kind of living the people of a group expect to have.

Here is what we mean when we say that shifting cultivators have a low standard of living. The people of our village can expect to have enough to eat unless storms, floods, exceptionally dry weather, insects, birds, or elephants destroy too much of the crop. They live from hand to mouth. For food they depend entirely upon their own farming. They have only the food that grows right there. At best their food is monotonous. Grain and starchy roots go into the kettle day after day. Now and then the father of the family brings down a bird with his slingshot or spears a fish. Once in a while one of the scrawny chickens goes into the pot, or a piece of stringy pork from one of the lean pigs. Often there is a little fruit. At the right season there are a few vegetables. Still, most of the food is starch—starchy grains and starchy roots.

There is nothing left over. A farmer and his family can work barely enough land to feed themselves year by year. With hand tools and primitive methods, two or three acres are all they can manage. If the crop is poor, the people go hungry, or they hunt in the forest for wild products to sell.

Standard of living does not refer to food alone. You saw how the shifting cultivators build their villages. The houses shelter the

people from rain and sun. They are not uncomfortable for people who are used to them; but they have no furniture, no window except an opening in the wall. The people have no electricity and nothing operated by electricity. Perhaps a few of them have been in a town and heard a radio, but they could never hope to own one. They do not expect to travel. They have few schools and no doctors. Their scanty and simple clothing is mostly homemade out of materials they raise or collect. Perhaps in a good year they may have just a little something to sell. Then they may buy a few yards of cheap cloth or a new knife or kettle.

The shifting cultivators work hard for a bare living. With their farming techniques, they cannot hope for more. Parents cannot hope that their children will have an easier life. It is likely to be harder. If the population is growing, the land will have to be worked too often. They must settle down and farm the same land year after year instead of clearing new land.

The shifting cultivators have learned one great principle of farming. They have discovered one way of conserving the fertility of the soil. They discovered and use the method of letting land lie fallow. That simply means leaving land unused to recover its fertility. Fallowing is probably the oldest method of conserving the soil. It is certainly the simplest. But it is also the most wasteful method, because it leaves a large part of the land unused each year.

MILLIONS OF PEASANT FARMERS

When shifting cultivators settle down, they usually become peasant farmers. The term is not easy to explain. It means subsistence farmers who cultivate small farms by rather simple methods. That is not a definition. It is just a foundation idea upon which you can build. A peasant farmer's life is bound up with his land. He uses techniques based on custom and tradition rather than science.

He probably knows little about the world outside his own community. His ways of working the land are almost sacred to him. In some regions of the world the techniques of farming really are a part of the religion of the people.

People with such ideas do not easily change them. Most governments in the world are trying to help farmers make a better living.

In parts of southeastern Asia government agents try to get the farmers to grow new crops. The poorest farmers, who most need help, are likely to say, "It is not the custom." That ends the discussion. Even their government has no right to ask them to do something that is not the custom—or so these farmers think.

Not all peasant farmers are descendants of shifting cultivators. Not all of them are in Asia. Not all of them have every characteristic that has been described. But you will learn more about such farmers by meeting a few of them as examples.

African Farmers

Some of the native farmers of Africa are shifting cultivators. Others have found their population growing too dense for shifting cultivation. They have had to settle down in one place and farm the same pieces of land year after year.

African villages. We might look at an example in southern Nigeria. From the maps in the Atlas section you can learn a number of things about the region. It is one of the most densely populated parts of Africa. It is near the equator, but far enough away to have a dry season. (See the map on page 59.) Total rainfall is heavy, with more rain falling in summer than in winter. The temperature is high the year round. The natural vegetation is tropical rain forest. There are still large areas of forest, but more of the land has been cleared than in most of the other African forest regions.

Tucked away in the forest are hundreds of villages of peasant farmers. The farmers scrape the ground into mounds, sometimes round, sometimes in the form of long ridges. The mounds and ridges are several feet across and several feet high. In this part of Africa yams are the most important crop. Yams need good drainage and are planted on the tops of the mounds. Other crops are planted

along the sides in the same mixed-up fashion as in the gardens of the shifting cultivators. Almost every garden has corn, beans, peanuts, pumpkins, and peppers. Some have cassava plants and other vegetables.

The grain must be harvested and stored in granaries. These are small houses, built just as the people's homes are. The root crops can be left in the ground until needed, and there are always vegetables to be carried home in the women's baskets. Since the growing season lasts the year round, there is always something in the garden ready for harvesting.

The people eat yams every day and at every meal. Other foods vary according to season. Yams are the *basic food*—the food that people really count on.

Basic foods in Africa. Everywhere in Africa the native subsistence farmers grow a crop as their basic food. It is always a crop that grows well and produces abundantly in the region. It is always a starchy food, too. Starch is an energy food, as you may have learned in your school health lessons. It can make up a large part of the diet if necessary. People can live and work without very large quantities of other foods. They must have some, however.

Yams are not a basic food everywhere in Africa. Only the regions of the equatorial rain forests are rainy enough and warm enough for them. They do produce large quantities of food for the land and work required to raise them. That statement does not mean that African farmers are lazy. They work very hard, but without modern farm implements they cannot cultivate very much land. They must put a great deal of work into their little patches to make them produce enough food for the family.

In some parts of tropical Africa cassava is the basic food. This plant will grow where the dry season is a little too dry for yams. You know, probably, that cassava is the basic food of the primitive Indians of the Amazon Valley. The plant was taken to tropical

Africa from tropical America, probably by Portuguese traders.

Corn is grown over a large part of Africa. In many of the drier areas it is the basic food. This is especially true in South Africa—not merely in the Union of South Africa, but in all parts of the continent of Africa south of the tropics.

Corn, like cassava, was taken to Africa from America. Again, it was probably the Portuguese traders who took it. Peanuts and various kinds of beans also came from America. They are important in the African diet because they supply some of the same food substances as meat, which is scarce in many parts of Africa. Tomatoes, sweet potatoes, pumpkins, and various kinds of peppers are other American plants now grown in Africa. African farmers are among the people who have reason to be very grateful to the American Indians, although many

of them probably have never heard of the Indians and have only the vaguest ideas about the Americas.

You might wonder what the Africans ate before they had these American crops. Were they all hunters and collectors? Probably they did depend upon wild foods more than they do now, but they were also farmers. The American plants were introduced about four hundred years ago, and Africans have no records of an earlier time. The evidence indicates, though, that yams were the basic food in tropical areas, as they are now. They seem to have been brought to Africa long before by Arabs, who got them in southern Asia. In the drier parts of Africa millets were the basic food. Millets are still the basic food in parts of Africa that are too dry for corn.

Since the millets are used very little as human food in North America, you may not know much about them. We usually speak

Primitive farmers use primitive methods. Two men in the Sudan region of Africa are threshing millet with sticks. A third tosses the threshed grain into the air so that the wind will blow away the chaff.

Courtesy British Information Services





Burton Holmes from Ewing Galloway

A housewife in tropical Africa pounds grain in a mortar so she will have meal to boil for mush.

of “the millets,” not “millet.” The word is used for a number of different kinds of plants that are not really very much alike, except that they are all cereal grains; that is, they are all large-seeded grasses. The millets seem to have been native to Africa.

In general, the millets are divided into two kinds, large millets and small millets. Sorghum is one of the large millets. It is grown as a feed crop in many parts of the United States, especially in the drier sections. You may have seen it growing.

In general, the Africans do not make bread from their basic foods. Almost everywhere the main starchy food is prepared in the same way, whether it is corn, millet, yams, or cassava. All are made into a kind of mush. The roots are usually boiled and then mashed. Grains are threshed and then winnowed to get rid of the chaff. This is usually done by tossing them into the air on a windy day. The chaff blows away while the heavier grain

drops to the ground or is caught in a basket. To prepare a meal, the housewife usually starts by pounding the grain in a mortar. The picture shows what a mortar is. The woman pounds the grain until it is crushed into meal. Then she boils it in a kettle to make mush.

Whatever the starchy food may be, it is served every day at every meal. Other foods are used as relishes or sauces and eaten with the mush. The relish may be boiled vegetables or sometimes a meat stew.

Most people in the world get a large part of their nourishment from one basic food. In general, the simpler the culture and the farming techniques, the more people rely on their basic food. For example, in south-eastern Asia the basic food is rice. Most of the people get 80 to 90 percent of their nourishment from rice. Wheat bread might be considered the basic food of most of the peoples of western Europe. At least the people eat more wheat bread than any other one food. The French have a reputation for being great bread eaters; but even they get only about 40 percent of their nourishment from bread.

Peasant Farmers of Asia

Asia has farmers who are shifting cultivators, as you have seen. It also has many scientific commercial farmers. Out of the vast population of this largest of continents, both groups are small. A great majority of the people of Asia are peasant farmers. Some of them live in southwestern Asia, in the region where farming probably began, thousands of years ago. Perhaps you would like to turn back to page 54 and read again about those first farmers. Check the climatic maps, too, including the rainfall map on page 59.

Arab villages. Southwestern Asia is a dry land, especially in the summer. Many crops must be irrigated. Like most peasant farmers, the farmers of southwestern Asia

live in villages. In this region the people who founded a village had to think first of a water supply. Year-round streams are not plentiful. The people who live beside one are very fortunate. Other villagers have found water by digging wells. Still others have to depend upon catching and saving rain water in pits and cisterns.

Most of the peasant farmers of southwestern Asia call themselves Arabs. They speak Arabic and believe in the Moslem religion. Arabs from Arabia conquered this land more than a thousand years ago. They brought with them their language and religion, but they did not kill or drive out all the people who lived there. The present population is made up of descendants of both the Arab invaders and of people who have lived in the region from very early times, perhaps from the time of the first farmers.

Near the center of every Moslem village is a mosque. Close by is an open space used as a market and as a place for people to gather. Houses, usually of adobe brick, surround the market place. Narrow, crooked streets separate the houses. Around the village is the farm land. Each family has its own fields. The land nearest the village is usually planted with vegetables. Beyond the gardens are orchards and grainfields. Still farther away are pasture lands.

Olives, oranges, figs, and apricots grow in the orchards, and there are usually a few date palms, too. Fine grapes and melons are grown. The grains are wheat, corn, millet, barley, and rice. Farmers grow barley mainly as feed for their horses, donkeys, and mules. Wheat and rice are used entirely as human food. The people eat part of the corn and millet and feed part to their animals.

The land is divided into many tiny patches rather than fields. When the father of a family dies, the land is shared among the sons. This dividing and redividing has gone on for hundreds of years. The family may have bought land when a patch was for sale. Thus the lands of a family are likely to be scattered. One way and another the land

has been broken up into strange patterns of small irregular fields.

The peasant farmers of southwestern Asia use plows pulled by oxen. The plows are made of wood and are simple. Other tools, too, are simple. Many of them have not changed much in several thousand years.

Grain is grown in the winter, as it is in most Mediterranean lands. The grain is sowed by hand and harvested with a sickle. The farmers spread the stalks on a threshing floor, usually an area of hard-packed earth. They thresh the grain with a threshing board. This is a large board with stones or teeth set in the underside. An ox drags it round and round over the threshing floor until the grain is separated from the straw.

Wheat bread is the basic food. The people cannot imagine a meal without bread. Many villages have community bakeries, where the women of the various families take turns at the ovens. Neighbors help one another with the baking. Baking day turns into a party when a group of women sit around a table, pounding dough into thin loaves of bread.

Next to grain, olives are the most important crop. The harvesting of olives is almost a ceremony. The village elders—the village council, we might say—decide when olive gathering shall begin. It is usually some time in January. Men beat the trees with long sticks to bring down the ripe fruit. The women and children gather up the olives from the ground.

The women of each family pickle enough olives to last for a year. Here pickling means the same thing it did in the case of pickled herring—preservation in strong salt water. The men take the rest of the olives to the press to be made into oil. To crush the olives and press out the oil, a stone roller is pulled round and round on a stone platform by an ox. Olives have been crushed in this way for hundreds and hundreds of years. Have you ever read about lamps in the Bible? Those lamps burned olive oil extracted on just such a press as this.



Ewing Galloway

This adobe dwelling at the edge of a Moslem village overlooks the hard-packed earth of the village threshing floor.

The villagers give the owner of the press part of the oil as pay. They take the rest home and put away a year's supply in jars, to be used in cooking. Usually there is some left over to sell.

About three-fourths of the people of southwestern Asia are still farmers. Not all of them are subsistence farmers like the villagers we have seen. Alongside these peasant farmers live commercial farmers who grow special crops by the most up-to-date methods. Also alongside them live nomadic herdsmen who get their living from the earth even more simply and directly.

The peasant farmers are subsistence farmers, but they are not quite self-sufficient. That means that they do not produce on

their land quite everything they use. When they have plenty of grain and oil stored away, they have the most important foods. Besides, they can usually count on milk, butter, and meat from their animals, and on fruit and vegetables from their gardens. If there is no surplus left over, they will not starve, but they do like to have a little surplus to sell. They want certain things that money will buy. They want coffee to drink. Some wear Arab clothing made from the wool of their own sheep, but more of the village families wear European clothing. This must be bought. Busses now run along the ancient highways, and it is pleasant to take a bus trip sometimes. Now and then someone in the village saves enough money to buy a radio or perhaps even an automobile. Now and then a family sends one of its children away to college.

Here is a mingling of cultures. One of the oldest cultures in the world lingers on. In many ways it is almost unchanged. In the

same region are modern cities, railroads, automobiles, factories, and all the occupations found in western Europe or America.

The most crowded land in the world.

If we move to the eastward looking for peasant farmers, we shall find millions of them in India. Here again is a land of villages. It is far more crowded than southwestern Asia. But let us go on, looking for a still more densely populated region. For contrast with the dry lands of southwestern Asia, we shall take an example from the island of Java in the tropical-forest region of Indonesia. Compare the two regions on your climatic maps in the Atlas section in the back of the book.

The island of Java is the most densely populated large area in the world. On most maps it looks like a very small spot, but that is because we seldom see large-scale maps of Indonesia. Java is larger than Pennsylvania or Mississippi. It is just a little smaller than North Carolina, but it has more than thirteen times as many people. It has no large cities, but it has nearly a thousand people to the square mile. These are nearly all country people. Village people, rather. The population of Java is not evenly distributed. Some parts are so sparsely populated that the people still make a living by the wasteful method of shifting cultivation. This means that other areas must support many more than a thousand people to the square mile.

Farms are small, but if possible a family owns land in three locations: (1) a garden spot near the house, (2) land that can be irrigated for rice, and (3) dry hillside fields. Every family has a garden. The garden surrounds the house or at least is very near it. If you look at the garden from a distance, you see only a grove of tall trees. These are coconut palms and many kinds of tropical fruit trees. Perhaps their names would not mean anything to you. Mango, sapodilla, and durian are some that you might know.

As you come closer to the garden, you see that lower trees and bushes grow beneath the tall trees. Here is a tree with ripe oranges, and over there is a banana plant, with a tall papaya plant beside it. Clumps of bamboo grow in the Javanese garden. The stalks are much larger than the bamboo fishing rods you have seen, and the people use them for a great many things. They are the most commonly used building material. Sections of them make good water pails or storage jars for rice. If you lived in south-eastern Asia or the islands, there would not be much of anything you could not do with bamboo. The young shoots are even a good vegetable.

The trees and bushes make the two upper stories of the garden. There is also a ground floor. Maybe we should call it the ground

floor and basement, for some of the products grow underground. Sweet potatoes, yams, and a root crop called taro make up part of this lowest layer. Scattered about are several kinds of beans and other vegetables.

By this time you probably expect to find the gardens looking like a confused tangle, with the plants all mixed up together. To you it does look like a confused tangle, but to the Javanese farmer it looks like a very properly planted garden. He is right, too. He can use every bit of the soil all the time. When one plant has finished bearing, he puts another in its place at once. Thus he gets all the benefits of crop rotation, almost square foot by square foot.

The garden plants are all very well to add variety and interest to meals, but the basic food is rice. For his rice the farmer needs land that can be flooded. The farmers put a vast amount of work into their rice fields. Each field must be level, so that the water can be kept at the same depth over the whole field. Dikes of earth must be built around

The work of building and repairing terraces is endless. Each terrace is a shallow basin with irrigation water spilling over to the terrace below.

Ewing Galloway



the leveled-off areas. In some places there is not enough level land. There the farmers terrace the hillsides wherever they can bring water to the terraces.

Where the land is always wet, the farmers use water buffaloes for plowing. If the fields are dry before flooding, oxen are used. A great many kinds of rice are grown. Some will ripen in sixty days; others require as many as three hundred. The slow-growing kinds yield more grain but take more water. Perhaps there is not enough water for the slow varieties. Or perhaps the farmer thinks he will do better to grow two crops of a fast-growing variety.

If the fields are dry during part of the year, the farmers grow corn, beans, and vegetables during the dry season. This rotation of crops increases the produce from the land and improves the soil. The farmers also grow plants, especially legumes, which they do not harvest. Instead, they plow the plants into the ground as fertilizer.

Many farmers have a third kind of land, dry fields in the hills. Corn, cassava, sugar cane, sweet potatoes, peanuts, beans, soybeans, and upland rice are the crops usually grown on the dry fields.

Farmers of southern China. You could find much the same kind of farming all over southeastern Asia, in Malaya, Siam, Burma, and Indochina. The cultivation is less intensive where the population is less dense. There are differences due to the differences in climate, soil, and customs. Some of the people are more primitive farmers than the Javanese. The differences are interesting, but everything will not go into one book. We shall take a long jump to China now.

China is a very large country—larger than the United States. No one knows the exact population, but China probably has about three times as many people as the United States. One cannot generalize about so large an area or so many people. The descriptions that follow do not tell you about all Chinese farming.

We might look first at one of the most productive parts of China, the lowlands near Canton. In this region rice is the basic food. Consult the maps in the Atlas section at the back of the book. The rainfall is more than 60 inches a year. The heaviest rain comes in summer, but there is enough for crops in winter, too. The growing season lasts the whole year round. Summers are hot and winters are cool.

Here the water buffalo splashes with his wide feet as he drags a wooden plow through the rice fields. Farmers wear wide straw hats and straw coats to protect them from the heavy rain. Mulberry trees grow on the dikes between the rice fields. In the houses, thatched with straw, silkworms spin the mile-long threads that make their cocoons. On the neighboring hills girls in bright cotton dresses pick fragrant tea leaves. Graceful bamboo waves its slender stalks.

To the Chinese people who live here, life is an endless round of hard work. In early spring the rice is planted in the seedbeds. Then the muddy fields are plowed, and fertilizer is worked into them. The fertilizer is anything that will add a bit of plant food to the soil—weeds, rubbish, animal manure, sewage.

When the rice plants are a few weeks old, they are pulled up, tied in bundles, and carefully planted, one by one. The planters work long hours, backs bent, feet and hands in the dirty mud of the rice fields. While the rice grows, the fields are weeded several times. But the weeds are not carried away and burned. Not in China. They are pushed down into the mud to add fertility to the soil. Women and children go over the field to pick off insects. As the grains form, boys and girls drive away the birds.

At harvest time the rice is cut by hand with a sickle. Some farmers thresh it with a flail and some with a stone roller that is dragged over a threshing floor.

When the harvest is good, the people are happy, but still they do not have nearly enough rice. Already new rice plants are



John Gutmann from Pix

This scene is typical of southeastern China. Simple plows pulled by water buffaloes stir the muddy soil in preparation for planting rice. The earth ridges that cross the fields keep the water from flowing away. Steep hills, terraced wherever possible, are also typical of the region.

growing in the seedbeds. Again there is the row of bent backs in the rice field. Again there is the grassy green of young rice plants above the water. Once more there is weeding, bird chasing, and the search for insects. Then toward fall there is another harvest and more rice for the granary. Probably now there is enough. Famines are unusual in this part of the country.

It is fall, but the year's farm work is not over. It will never be over. Rain falls less often and the rice fields dry; but like the people, the fields still have work to do. This

time sweet potatoes are most likely to be the crop. A few green vegetables can also be grown during the winter.

Most farmers manage to raise a little something to sell. They have an orange tree or a fig tree or a little sugar cane. Of course they sell the silk their silkworms spin. They must have a little money, but they have very little.

Farmers of northern China. Many Americans believe that all Chinese people live on rice. Perhaps it surprises you to learn that very little rice is grown in northern

China. Wheat is the principal grain, but it is not a basic food as rice is in southern China. The northern Chinese have quite a variety of other foods.

Environment divides northern China into several regions, but we must choose one. Suppose we take the lower valley of the Hwang Ho. This is another very densely populated region. It is in about the same latitude as North Carolina. You might like to compare the two regions on your maps.

The center of farm life is the village community, as in other lands of peasant farmers. Around the village every inch of land is farmed. Everyone in the family works. In all regions of peasant farming, occupation graphs do not quite tell the truth. Fathers, mothers, sons, daughters, even quite small children and very old people, work on the farm at least part of the year. The working population is practically the same as the whole population.

Our village is within the winter-wheat region of China. That means, as you know, that wheat is planted in the fall and is ready to harvest by early summer. There is still time for another crop. On much of the land this second crop is kaoliang, a kind of sorghum. Sweet potatoes are important, too. Some of the land is almost sure to be used for corn and some for soybeans. Near the village each family has a vegetable garden, which also requires much work in summer.

The village farmers do not leave any land fallow. They do rotate crops to some extent, but the land must produce too much grain for good crop rotation. The farmers cannot afford to raise green crops to plow under. Every bit of land must produce a crop every year. Farmers cannot even leave the plant waste to enrich the soil—the straw, the soybean and sweet-potato vines, the cabbage stalks, and the cornstalks.

There is a pig or two in the courtyard of the house, and an ox for plowing. Most families have a donkey to carry loads. The animals must have whatever wastes are nourishing for them. Plant wastes must also be

used for fuel. There is no wood lot to furnish fuel. Twists of straw in a brick stove warm the house and cook the food.

Very few farmers in the village ever buy any fertilizer. They know all about the value of fertilizer, but they cannot afford to buy it. They do not have enough animals to furnish much manure, but what they have goes into a pit in the courtyard. Along with it goes what we should call sewage and every bit of garbage that not even a pig will eat. There it ferments and blends. In spring the farmers shovel the contents of the pit out on the ground to dry in the sun. Visitors to Chinese villages talk about the terrible smell. The villagers know their piles of fertilizer smell bad. But they must have food and they must grow it on very little land. To do this, they must have fertilizer. How else could they get it?

According to their own standards, the farmers eat well in summer. They know they need nourishing food when they are working hard in the fields. Almost every day they have a little pork or fish. There are plenty of fresh vegetables. Porridge, cakes, and noodles are made of kaoliang or corn. Wheat is saved for holidays and special occasions. Soybean oil is used for cooking and seasoning. The whole beans are eaten, too. As soon as the sweet potatoes have grown large enough, they appear at every meal. During the fall and winter, other foods are used up. Then often for meal after meal, day after day, week after week, there is nothing but sweet potato.

Sweet potatoes can be stored, but they do not keep so well as white potatoes. Toward spring there are no more whole sweet potatoes, but the women and girls have provided for that. In the fall they spent many hours cutting sweet potatoes into thin slices. They dried the slices in the sun and air and stored them away. Toward spring some of these slices are boiled for every meal. The people want better food and more food, but they do not think they really need it in winter, when they are not working very hard.

Every bit of land the Chinese farmers can use is used already. There is no more land. The population is increasing. As it increases, the farms are divided, smaller and smaller. More and more people work harder and harder to get more food out of the land. Up to a certain point more work

does make the land produce more. Beyond that, the work is wasted. More work on a piece of land just will not make the land produce another ounce of food. The Chinese farmers do wonders to make their little farms support them. But sometimes the crops are poor, and there is a famine.

CHANGING TECHNIQUES OF FARMING

You have seen what peasant farmers are like. They probably work harder than any other people in the world and get less return for it. Most of them live in villages. They put vast amounts of hard work into small farms and get only a bare living in return. A living means enough to eat when all goes well. Their diet, food scientists say, is not good. They eat too much starch and not enough food high in vitamins; but they are satisfied because the food is what they and their ancestors have always eaten.

The real peasant farmer is conservative. The word means that he is slow to change his ideas and his ways. His farming techniques are based on custom. He plants the crops his neighbors plant and his ancestors planted. His farming techniques are like those of his neighbors and his ancestors. His ways of living, too, are like those of his neighbors and his ancestors.

The true peasant farmer supplies his own family with the bare necessities for living, but he does not supply anything for anyone else. If all farmers were subsistence farmers, every family would have to farm. Very nearly all our food and most of our clothing come from farm materials. If each farm family produced only enough for itself, there would be nothing to feed and clothe workers in other industries. Therefore, there could be no other industries.

In fact, it is only very poor or very primitive peasant farmers who have nothing at all to sell. In good years most of them have a little surplus. If that were not true, no part of the world would ever have broken out of

its round of peasant subsistence farming. The peasant farmer does not grow special crops to sell. He grows the customary crops in the customary way. If he has more than he needs, he sells what is left over and buys a new tool or something else he cannot grow or make.

You could find peasant farmers today in much of eastern Asia, in parts of Latin America, and over much of Africa. There are no real peasant farmers in North America north of the Spanish-speaking countries.

Many peasant farmers of Latin America still use oxen to pull farm implements and carts.

Jules Bucher from Three Lions



They do exist in many Latin-American countries, but not because the people speak Spanish or Portuguese. They exist because the Indians who lived there were peasant farmers before the Europeans came. Their descendants have remained peasant farmers.

Back to the Middle Ages

You would not find many peasant farmers in Europe today. There are practically none in western Europe. Many farmers of central and eastern Europe call themselves peasants, but that is just because words are slow to change. Most of them are not peasant farmers as scientists use the term.

Medieval peasants. Once all the farmers of Europe were peasant farmers. There was no other kind of farmer in the world. You have probably read about European peasant farmers of the Middle Ages. All their food was grown on the village land. The village miller ground their grain. The village blacksmith made and mended their iron tools. Their houses were built of materials from the land—stone from the fields, timber from the woodland, even twigs woven together and plastered with mud where no better materials were available. Roofs were thatched with straw from the fields.

The village land was usually divided into three large fields, and the fields were cut into long, narrow strips. A farmer held one or more strips in each of the fields. In any given year two fields were plowed and one was left fallow. One of the plowed fields was planted in grain. The other was usually planted with a number of crops: perhaps turnips, cabbage, peas, lentils, beans, flax, and a different grain from the one grown there the year before.

You see, there was just a hint of the old idea of shifting cultivation here. But these farmers of the Middle Ages knew another method of conserving the fertility of their land. They knew about rotating crops. Their rotation plan was still crude. They

did not have enough variety in their crops, and they came back too soon to the same one. They wasted a third of the land each year by leaving it fallow, although a useful crop would have done it just as much good. Still, they were learning.

The peasants of the Middle Ages had better food than most of the farmers of eastern and southeastern Asia have today. They had more meat. They also had milk, cheese, and butter. Around the fields was an expanse of meadow which all the village families might use for pasturing their animals. Cattle, sheep, and geese were taken out to graze. The peasants usually did not have horses, but they used oxen as work animals. For winter, each peasant could cut hay in the meadow; in addition, he saved straw from his grain. Straw is not good feed, but it is something.

Every village had a patch of woodland, too. Each peasant had a right to gather fallen branches for fuel. He also had a right to turn his pigs into the woods, where they fed on nuts, acorns, roots, mushrooms, and the leaves of plants. Around the peasant's cottage was a vegetable garden, usually worked by his wife and children. A fruit tree or two stood near by. A few chickens scratched in the dirt near the house. The family had a small supply of eggs and now and then a roast chicken. Most peasants kept bees, too. Honey was the only sweetening they had.

Peasant clothing was usually wool, winter and summer. The wool came from the family's sheep. It was clipped, spun, woven, dyed, and made into garments at home. The family liked to have a little linen, too. That came from flax, grown and processed at home. The word *processed* means the same thing as manufactured, except that you use process when you are thinking about what is done to the raw material, manufacture when you are thinking about the product. You process flax to manufacture linen. You process wheat to manufacture flour. In subsistence farming, most of a family's needs are

met by materials grown and processed on the farm, or at least within the village.

The European peasants of the Middle Ages probably made a better living than modern peasant farmers in eastern and south-eastern Asia. They were not better farmers. In fact, they were not so good. Their advantage was a sparse population. They were not crowded and could use more land.

The beginnings of industry. Toward the end of the Middle Ages, cities began to grow in western Europe. If you have ever studied the history of Europe, you know the story. At first trading was the principal business of the cities, but there was always a little manufacturing by handicraft methods. In time, manufacturing became more important than trading in some cities.

Here is an example of how the changes affected farmers. During the later Middle Ages, Flanders was famous for its woolen industry. Flanders is the coastal area of what is now Belgium. Gand, Bruges, and other cities had many spinners, weavers, fullers, dyers, and other cloth workers. People flocked to the towns to learn the various trades that were required to make woolen cloth by medieval handicraft methods. These people needed food. They needed it in a region that was thought to be a poor place for farming because the soil was sandy and not very fertile. They needed food and they had money to pay for it.

We do not know whether the cloth workers persuaded farmers to come to this region, or whether the farmers saw an opportunity and came of their own accord. At any rate, they came. They began to work on that sandy soil to make it fertile. The only fertilizers they knew were animal manure and plant wastes. To get manure, the Flemish farmers kept cattle. Of course, cheese and butter, made from the milk, were also products that could be sold and added to the city food supply. City people kept horses for riding and horses to pull wagons. The farmers hauled cartload after cartload of manure

from the cities. They hauled garbage and rubbish. All this they worked into the soil. Because of the fertilizers they used, they did not need to leave a third of the land fallow, as medieval peasant farmers generally did. They could use the land every year.

Those Flemish farmers were still mainly subsistence farmers, for they grew all, or nearly all, their own food. But they were beginning to be commercial farmers, too. They were using intensive methods for the special purpose of growing crops to sell. Their techniques were not the result of custom but were planned to meet a need. They used in their farming the best scientific knowledge of their time. They made new discoveries for themselves.

Belgium is now one of the most densely populated countries in the world, second only to Java. In every way except population density there is a vast difference between the two countries. Belgium is a highly industrialized country and its farmers use scientific methods.

The farms of Belgium are small, though not so small as the farms of China. Belgian farms do not have to be divided and re-divided so that every boy in Belgium can expect to own a piece of land some day. If you turn to the tables on page 350, you will see that only a small fraction of the people are farmers. Every Belgian has a choice of many occupations. In China or Java there is little chance to choose, for there are not many industries.

The Belgian farmers can choose their crops, too. In China, for example, most farmers must use their land for the crop that will produce the greatest bulk of food. Otherwise their families will not have enough to eat. Belgian farmers grow very little such food. They grow mainly vegetables and fruit, or they are dairy farmers. They grow foods that are high in value and hard to ship. Of course, they use at home some of the vegetables and dairy products they produce, but they are not subsistence farmers. They are commercial farmers, growing crops for



Courtesy British Information Services

Industrial regions are usually also regions of farming with machinery. Compare this harvest scene in industrial western Europe with the harvest scenes in the pictures on pages 55 and 69. A few men operating combines can harvest enough wheat to supply many people with bread.

the purpose of selling them. They do not grow much grain, because it is easy to ship. It can be imported from other countries.

In China you saw a densely populated land in which most people are farmers. The standard of living is low because each family has only a little land. Belgium, too, is a densely populated land, even more densely populated than China, but the standard of living is much higher. Belgium is an industrial country. That is the principal difference. The Belgian farmers are scientific. They can specialize. They have products for sale, and they have money to buy equipment and the best fertilizers. They do not have to make a living by farming, however, unless they want to, because there is other work to be done.

Keep the example of Belgium in mind as you read on. You will see how farming has changed in many regions of the world.

How industry affected farming. This story of Belgium gives you just one example of how industry led to commercial farming. Manufacturing slowly grew more important and occupied more and more people. Then,

in the middle of the eighteenth century, new machines were invented. Machines took over more and more of the operations of manufacturing. The steam engine was invented and was used to run ships and trains. With machines, a great many more articles could be manufactured. With steamships and railroads, more raw materials could be brought from greater distances, and finished products could be sent to more distant markets.

In industrial regions of the world, farming, too, became industrialized. New farming techniques took the place of the old methods of peasant subsistence farming. The Industrial Revolution brought almost as great a change to farming as it did to manufacturing. In fact, before western Europe could become an industrial region, the farmers had to be able to produce more food than they needed for themselves. They sold the surplus food and bought products of the factories. Thus both farmers and townspeople came to have a higher standard of living. The farmers had food grown on their farms and products made in the city factories. The city people had products of their factories and food produced on the farms.

Farmers Settled America

In your history books you have read about the great period of discovery and settlement that began about five hundred years ago. At that time most Europeans were still peasant subsistence farmers. The Americas were the first new lands opened to settlement. New lands called for new techniques. The settlers did not carry with them the old methods and ideas of peasant farming.

Settlers had products to sell. The first European settlers in the Americas were the Spanish and Portuguese. The discoverers, as you know, were looking for the spices and flavorings of eastern Asia. They were disappointed when they found that the Americas were not lands of spice and sugar cane, but they soon changed that. Sugar cane was among the first plants they brought to the Americas. When the first English settlers came to Jamestown, there were already great plantations of sugar cane in the West Indies and in tropical South America.

You know the story of Jamestown, the first permanent English settlement in America. The settlers were at first expected to send back timber and other raw materials. Most of their food was to come from England by ship. From your history you know that this arrangement did not work. The settlers nearly starved until they began to grow food. Their principal food crop was corn, which they got from the Indians.

A few years after the first settlement, the settlers discovered tobacco as a crop. The people of Europe had begun to use tobacco from the Spanish colonies, but they had not had much. The Virginia planters found that they could sell all the tobacco they could grow. Thus the first English settlers in America became commercial farmers. They grew most of their own food because they had nowhere to buy it, but they grew only as much as they needed.

In most of the colonies the settlers expected to be subsistence farmers, but they were

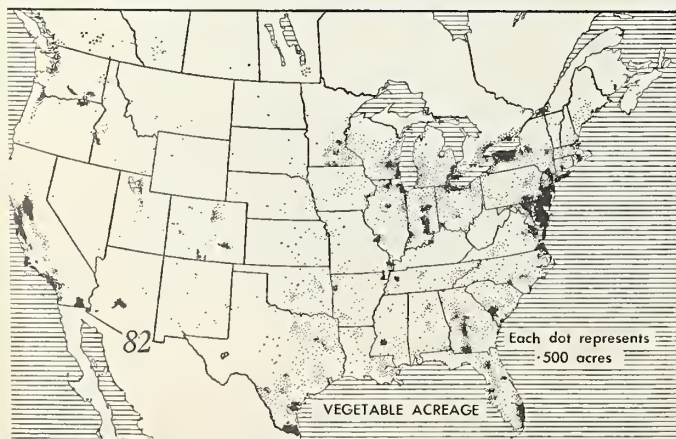
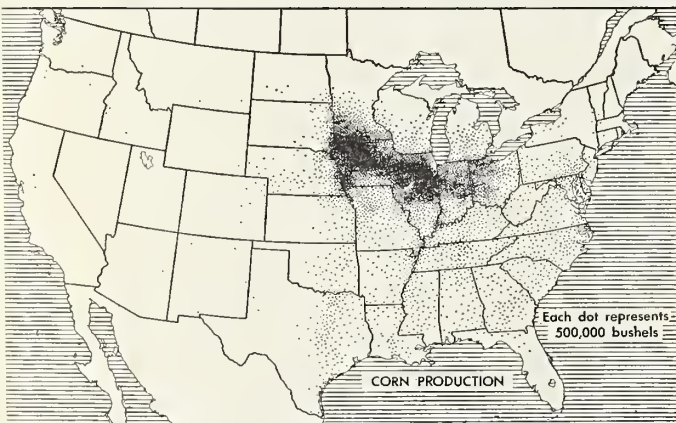
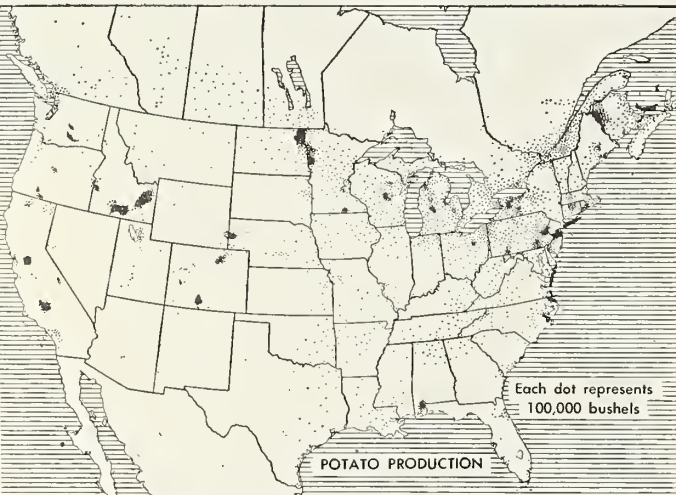
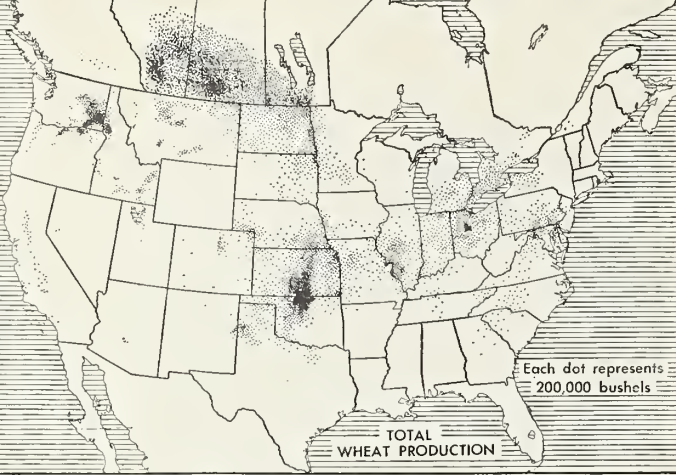
never peasant farmers. They could not bring to America their customary ways of working. A few tried and failed. In America farmers had to work out new techniques to fit the different climate and soil.

By the time the coastal region was settled, the colonists were exporting food products. Wheat and other grains, hams, bacon, and lard went out by the shipload.

Then settlement spread into what we now call the Middle West. The first pioneers were subsistence farmers. As soon as a region was really settled, however, the farmers wanted to trade. You have read, of course, that the United States government bought Louisiana in 1803 so that the middle western settlers could ship their goods freely down the Mississippi. The Erie Canal was dug so that farmers could get their products to market by water. The invention of the steamboat hastened the settlement of the South because it gave the settlers a way to market their crops. Later, the railroads opened up new areas farther west.

From this brief review of the history of American farming, you can see that it has never been peasant farming and never wholly subsistence farming. On the old-time farm, people raised and processed most of their own food, but from the beginning they also grew crops for sale.

The United States has been a leader in the change from simple subsistence farming, with techniques based on custom, to modern commercial, scientific farming. Modern commercial farming is planned farming. The farmer uses science and machinery to increase his production. He grows crops to sell, and so he grows the crops other people will buy. He lives very much as city people do. Although he may be partly a subsistence farmer, growing much of his family's food on the farm, he has a high standard of living. He wants much more than just enough food and clothing. He wants food he cannot grow, good and attractive clothes, an automobile, a telephone, a radio, electric lights, a pleasant, well-built, well-furnished home, medical



care, and education. He also wants leisure, vacations, travel, amusements, and a chance to have a good time.

The modern commercial farmer does not want to work from sunrise to dark all the year round; and so he buys machines to speed up his work. He does not want to make everything for himself. He wants to buy tools, farm equipment, fencing and building materials, seeds, and a great many other things. His wife also wants to buy clothing, furnishings for the home, and equipment that will make her work easier.

GENERAL FARMERS AND FARMING

On this page and the next page are eight American product maps. They show where the essential foods—meat, grain, potatoes, fruits, vegetables, and dairy products—are produced. Where do you find the most hogs, cattle, and corn? Wouldn't you say that a region from New York and Pennsylvania west to South Dakota and Nebraska led in all these products? The same region produces large quantities of vegetables, fruit, potatoes, and wheat. You have learned to call part of it the corn belt and parts of it dairying regions. You have learned, too, that regions are often named from their most outstanding product, but that it is never the only one.

For your present study, you may think of this whole area together as the world's greatest food-producing region. Many millions of people could have a good and varied diet without eating anything from outside this area. It is the best example in the world of scientific general farming, with crops produced mainly for sale.

General farming means the growing of many crops. It is the opposite of specialized farming. Sometimes the term mixed farming is used instead. It means a combination of crop production with the keeping of animals. Both terms are correct for this region.

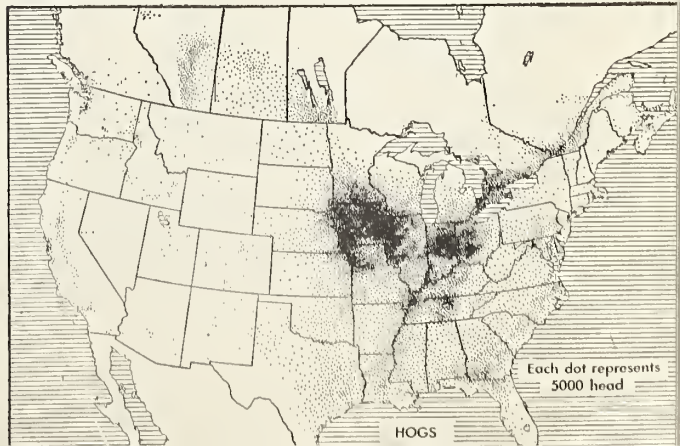
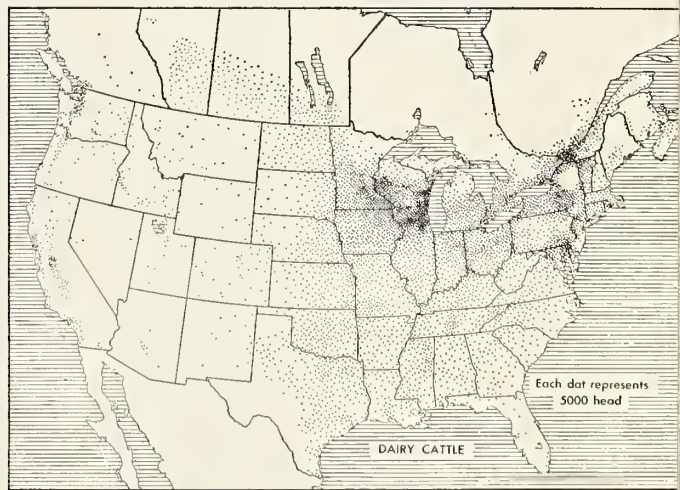
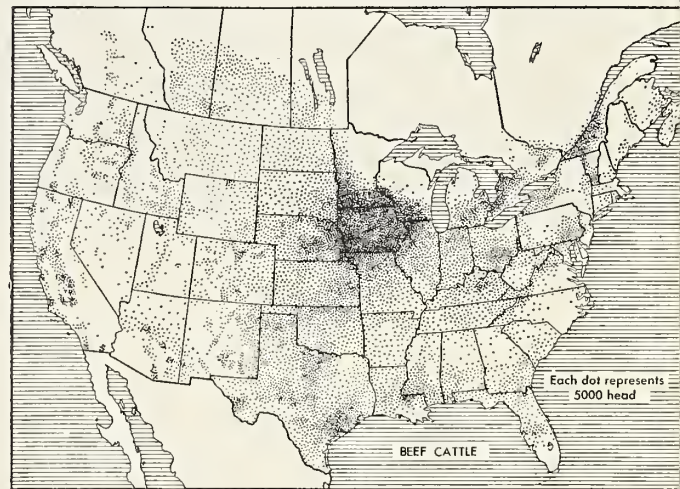
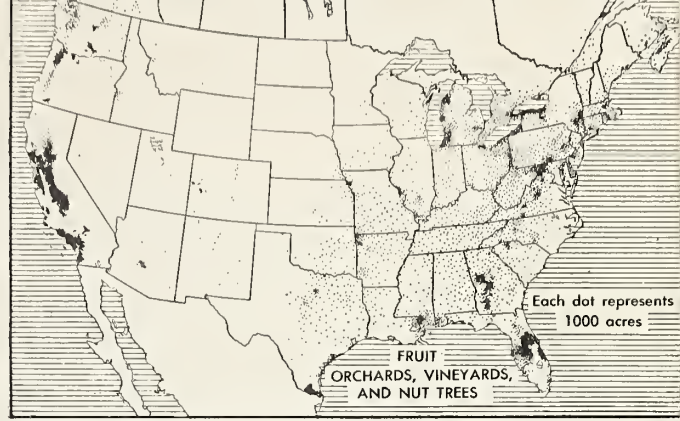
Midwestern Farms

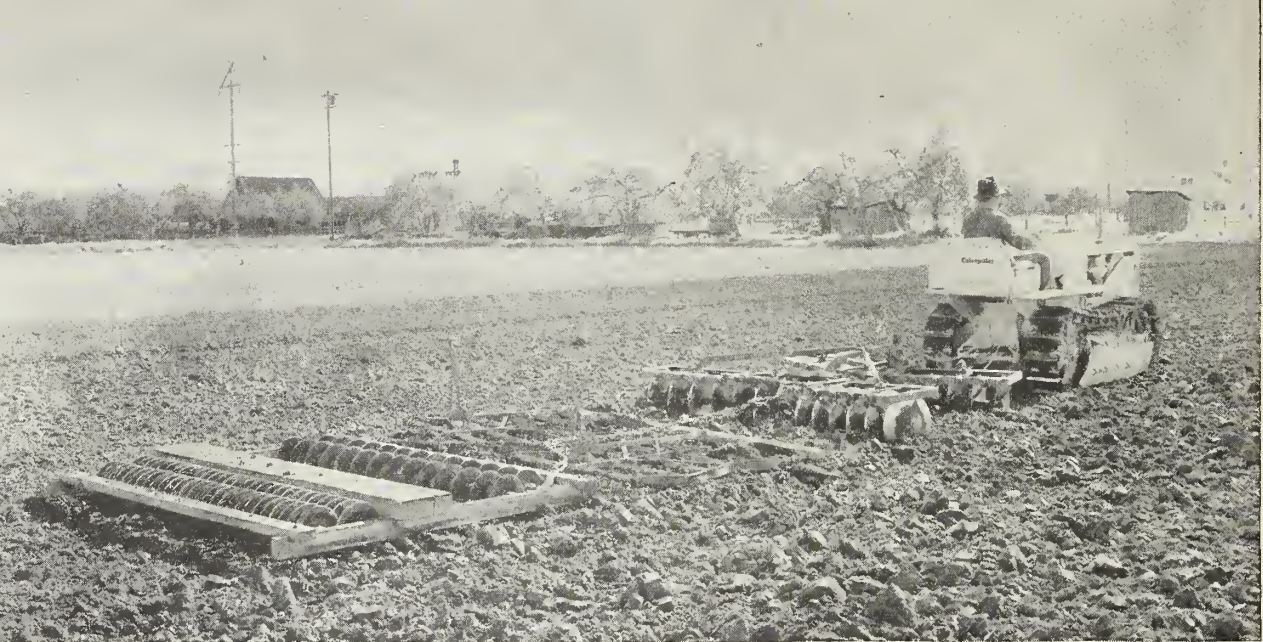
Before you read farther about the general farming region of the Middle West, look at the maps in the Atlas section at the back of the book. You should be able now to work out your own generalizations about climate. Next look at the population map on pages 374-375. You see that this section has a dense rural population and also many cities, some of them very large. Then notice the railroads. Nearly all the railroads in the United States seem to center in this region. If you turn to the historical maps on pages 376-377, you see that this was the first region in the United States to have a close network of railroads. You see, too, how the present population pattern grew up.

Large cities mean a large industrial population. For all its huge production of farm crops, less than 20 percent of the workers of the Middle West are farmers. Those other 80 percent are one reason for the heavy food production. They make up a great market for farm crops. Added to the urban population of this region as a market are the people of the densely populated area of the eastern coast. You see, then, that middle western farmers have the first requirement for commercial farming, a convenient market for their products.

Farms in the Middle West are large. A farm of eighty acres is considered small. Many farmers have 160 acres, which make up a quarter section. That means a quarter of a square mile. A good many farms are larger than that, but in most cases one family, with perhaps a hired man, does all the farming. Perhaps extra help is hired for a few weeks at the busiest season.

You saw that in China a whole family works all the time to cultivate three or four acres. Are the Americans better farmers, do you think? It depends on what you mean. Imagine an American family on a tiny Chinese farm, with Chinese equipment and the necessity to provide all the family's food. Undoubtedly the Americans would starve.





Philip Gendreau

Mechanized farming in a general farming region. The tractor is pulling three implements needed to prepare the soil for planting. Dozens of men would be needed to do the work by hand.

Their Chinese neighbors would consider them the world's poorest farmers. A Chinese family suddenly moved to an American farm would not starve but would not be able to cultivate all the farm, either.

The Chinese farmer has only a little land. He forces every square foot of his land to produce every possible pound of food. He wastes no land, but he wastes work. He puts much extra work into the land when that work gives him only a little extra food. He farms his land very intensively.

The American farmer has much more land than the Chinese farmer. He also has machines. If you look into the tool shed of a well-equipped middle western farm, you will see a tractor or two, plows that will plow several furrows at once, a manure spreader, seed planters, cultivators of various kinds and shapes, a mowing machine, a hay baler, a combine, a corn picker, a truck with a trailer. In a corner somewhere are bags of commercial fertilizer. The farmer knows that these will supply just what his soil lacks. If it is spring, there will be bags of seed with the grower's name on them. They are varieties specially developed for just this climate.

They have been tested and guaranteed to grow. All these things represent the farmer's *capital*. People sometimes use the word capital as if it meant only money. It may mean the money to buy equipment, but it also means the equipment itself. Capital is the money and the equipment used to produce something.

The middle western farmer uses much capital in producing his crops. The Chinese farmer uses almost none. The American farmer may have the help of just one hired man or perhaps of his own children; but his machines multiply the effectiveness of his work. It becomes equal to the work of dozens of men. His machines leave those men free to do other kinds of work. They are part of that 80 percent of middle western workers who are not farmers. A hundred years ago the figures were almost exactly opposite. A little over 80 percent of the people of the Middle West were farmers; less than 20 percent were in other occupations. Check with the graphs on page 381. Machines are not the only reason for the difference, but they are certainly one of the most important reasons.

Corn-belt farmers. Imagine you are driving along a road in the central part of the corn belt, perhaps in Indiana. The time is early summer. The leaves of the young corn wave like green pennants in the wind—acres and acres and acres of corn. The cornstalks are evenly spaced in straight, regular rows. Between the rows the soil is soft and fine. There are no weeds. You would think, if you were a Chinese farmer, that a whole village must work all the time on each of these big fields to keep them so well cultivated. Then you see a field in which a man is working—just one man. He is driving a tractor that scurries across the field. Fastened to it is an appliance that cultivates eight rows at once. He can cover this big field in a day or two. This is his last time over it. The corn will be too tall for the cultivator to go over it again.

As you drive on, you see small combines at work in wheat fields, cutting and threshing the grain. Wheat shocks stand in other fields. These have been cut with binders and are waiting for the threshing machine.

Here is another farmer cultivating a field of potatoes. He is using a tractor. His son, in the next field, is driving a team of heavy horses hitched to a mowing machine. He is making hay in a field of red clover mixed with timothy, a kind of grass. Many corn-belt farmers keep no horses at all. Their farms are fully *mechanized*; that is, all work is done by machine. Others like to have a team of horses for some of their work.

From your automobile you see fields of oats, fields of alfalfa, fields of soybeans, fields of tomatoes, cucumbers, melons, pumpkins, squashes. Where the land is low and the soil is dark, there are fields of onions. Besides the cultivated fields, almost every farm has pasture land, with cattle and pigs. Sometimes you see flocks of sheep. Most barns have silos beside them.

Looking at the land with its many crops, you might wonder why this is called the corn belt. The corn map, page 82, explains. More corn is grown in this area than any-

where else in the world. Where rice is grown in large quantities, it is a basic food. Corn is not, however, a basic food in the corn belt. The farm families of the corn belt eat very little corn. They do not sell much of it. What do they do with it?

That sounds like a riddle, but you probably know the answer, whether you live in the corn belt or not. The farmers feed their corn to animals, especially cattle and hogs. Not all of the farmers, of course. Many of them have more corn than they need and sell part of it.

Most farmers and agricultural experts agree that corn is the best of all grains for feeding animals. Why, then, do the corn-belt farmers raise so many other crops? One reason is that animals need more than one kind of feed. They need a well-balanced diet, just as people do. The farmer keeps part of his land in pasture because fresh green feed is good for his animals. Much of it is the natural grass that grows wild in the region. Perhaps the farmer has sowed other grasses, but he does not need to do this often. He does not need to cultivate the land. He does not need to harvest the crop. The animals do the harvesting for him. He may have land that should not be used for anything but pasture. It may be low, wet land where crops are likely to be drowned in all but the driest years. It may be hilly land that will be eroded badly if it is plowed. But even if every bit of land would produce good crops, the farmer still keeps many acres in pasture. His animals need the grass.

In winter his animals need roughage; that is, they need food that is coarse and bulky, along with their highly nourishing and fattening grain. For this coarser feed, the farmer grows much hay. Unless you have never seen a farm or read anything about farming, you know that hay is not the name of a crop. A farmer would never say he intended to plant hay. He would say he was going to plant clover, or a mixture of clover and timothy, or soybeans, or alfalfa, or a small grain such as oats to be cut for hay.

Plants are cut for hay while they are green. Then they are dried in the field and stored in the loft of the barn. Some hay crops, alfalfa, for example, grow up again after they have been cut. They can be cut two, three, or more times, depending upon the length of the growing season. To give the animals green feed in winter, the farmer puts cut-up cornstalks, soybean stalks, or other green plants in his silo.

The farmers have another reason for growing a variety of crops. They are scientific farmers and know the importance of rotating crops. A farmer may grow corn in a field one year. The next he is likely to grow wheat. The third year he may grow a different small grain—rye or oats, for instance—to cut for hay. The fourth year he will grow a legume, probably clover or soybeans. There are many possible rotations, differing according to soil, surface, the farmer's needs, and his preference.

Corn is a "row crop." It is planted in rows and cultivated to keep out the weeds. Even on nearly level land there will be ero-

sion. Wheat and other small grains are good to follow corn because they cover the ground closely and hold the soil in place. If any erosion has begun, it will be stopped before it has time to do much harm. Every rotation should include a legume crop, such as clover or soybeans, because legumes enrich the soil. If a farmer is careful of his rotation, and if he uses animal manure wisely, then, in all probability, he does not need to buy much fertilizer.

There are still other benefits from rotation. The roots of different plants grow to different depths in the soil. Some use the plant foods near the surface, while others take foods from much greater depths. Thus the farmer gets full benefit from the fertilizer he uses. The different crops also spread the work. For example, the farmer plants wheat in the early fall, hay crops in the early spring, and corn later in the spring. He harvests wheat in the early summer, corn in the late fall, and cuts plants for hay and silage whenever it is convenient during the summer. He may raise vegetables partly for the same reason.

They spread the planting and harvesting still more. Thus rotation makes it possible for him to get full benefit from his own time as well as from his soil and fertilizer.

A crop that covers the soil will stop the erosion in this field.

Soil Conservation Service OH-30216



A farmer's unseen helpers.

A corn-belt farmer may be riding his cultivator across a cornfield all alone, but he is not really working alone. He has many helpers who are not in the field with him. He knows that if he sends samples of his soil to the state agricultural experiment station, the scientists there will tell him what crops he should plan to grow in it and what fertilizers he should use. He can get bulletins from the United States Department of Agriculture on each of his crops and on each

kind of animal he raises. He can get information on diseases and insect pests. If he has a special problem, he can consult the county agent for help. From these same sources he can learn what plant varieties and breeds of animals are best suited to his location.

He does not need to go to the work of saving his own seed. He can get much better seed from the seed companies. Seed companies have varieties carefully developed to suit different regions. Their seed is *standardized*, too. This means that the seed will produce a crop that is all alike. A farmer can usually get a higher price for a crop when it is all alike than for a mixture of different sizes and varieties.

Our farmer riding his cultivator across the cornfield probably belongs to one or more associations of farmers. He may belong to a coöperative society. All the farmers who are members sell their products together and perhaps buy their seed and fertilizer together. In this way they get more favorable prices, both buying and selling. The farmer may belong to a hog or cattle breeders' association. The members of such associations exchange information. They may have a magazine telling about methods and markets. There are also many radio programs to help the farmers.

This book does not have enough space to tell you about all the ways in which other people work with the farmers, but here is an example. It is the story of hybrid corn. A hybrid, you know, is a cross between two different varieties or breeds of plants or animals. For seeds to develop on any plant, a grain of pollen must fall on a part of the flower called the pistil. The corn plant has two kinds of flowers. The tassel at the top of a cornstalk bears flowers. No, they do not look like roses or violets, but they are flowers



Courtesy American Agricultural Chemical Co.

Agricultural scientists study plants to help the farmers grow better crops and make their land more productive.

just the same. These flowers produce pollen. The other flowers, which are inside the husks of the young ear when it first appears on the cornstalk, look even less like flowers. Each strand of corn silk is the pistil of one of these flowers. For a grain of corn to develop from one of the flowers, a grain of pollen must fall on the strand of silk.

Ordinarily corn pollen is carried by the wind from tassel to silk. No intelligent farmer would plant a patch of popcorn anywhere near his field corn. If he did, the wind would carry pollen from one kind to the other, and the corn would have a great many grains that were hybrids between popcorn and field corn.

Hybrids may be much like one parent or much like the other or different from either. Seeds saved from a hybrid plant may be very different from the parents. Plant breeders have used this variability of hybrids for a long time. They hybridize two varieties and

get a number of different kinds. Then they select the best.

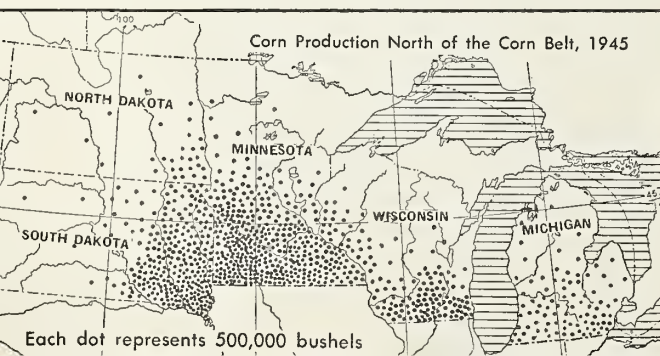
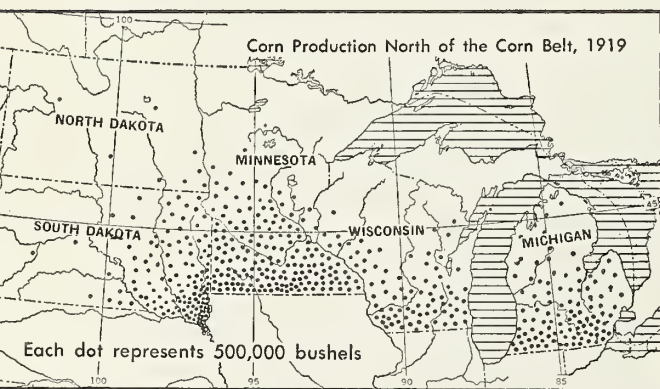
Corn is the most valuable crop in the United States. The experts of the Department of Agriculture decided to try to make some real improvements in it. They began by growing separate plots of corn. Over many years they selected seeds from plants that showed special traits that might be valuable. When they had many different varieties of plants, they began to hybridize these varieties.

Suppose, for example, there is a variety that is resistant to disease but has small ears. A second variety has large ears with deep kernels, but is not resistant to disease. The experts hybridize the two. The seed will possibly produce corn that is resistant to disease and also has large ears. Sometimes more than one cross is needed, but the experts discovered that they could breed into corn almost any quality they wanted. They also discovered that hybrid corn is more vigorous. It grows better than either parent and is more productive. Now there are strains of hybrid corn for almost every combination of climate and soil. Most corn-belt farmers use hybrid seed and get increased production.

The growing of hybrid corn has had another interesting result. If you should read about corn in a book published forty years ago, it would tell you that very little corn was grown for grain north of Indiana, Illinois, and Iowa. The old book would say that the growing season farther north was too short for corn to ripen. It would tell you that the farmers farther north kept many dairy cattle and grew corn for silage. Since this corn was cut before it was ripe, the short growing season did not matter. Now those farmers can get strains of hybrid corn that will ripen in less time. The maps on this page show the increased production.

Dairy farmers. The general-farming area extending eastward from Iowa and Minnesota is not alike everywhere. Farmers everywhere grow grain, but the other crops differ from place to place. For example, sugar beets are grown in some places but not in others. Some farmers specialize, although they live in a region of general farming. There are dairy farmers, truck farmers, poultry farmers, and fruit farmers.

Two large areas are usually described as dairy regions, although not all the farmers are dairy farmers. One dairy region is in central New York. The other extends westward from Lake Michigan to Minnesota. Eastern Pennsylvania also has many dairy farms. The climate is good for hay and pasture, but it is really the markets for milk and milk products that have led so many farmers to specialize in dairying. The eastern region supplies milk and milk products to the cities along the Atlantic coast. The western dairying region supplies the same products to the Chicago metropolitan area and other cities in the region. Outside these two regions there are many dairy farms scattered over the whole Middle West. Wherever in the world there are city people with a high standard of living, there are dairy farms. On the whole, it is true throughout the world that the higher the standard of living, the more dairy products people use.



In earlier geography courses you learned how the dairy farmer cares for his cows. There is no need to repeat the story here. But caring for cows, milking, and selling the milk are not all of a dairy farmer's work. To make dairy farming pay, the farmer must raise most of his own feed. He therefore spends much of his time raising hay and grain. He is very likely to plant especially nourishing grasses in his pastures, too.

Scientific dairy farmers keep very careful records. They weigh the feed of each cow and weigh the milk she gives. They test the milk for butterfat and keep a record of that. They experiment with different kinds of feed to see which gives the highest production. Most of them belong to dairymen's associations. The best animals are registered with these associations, and production records are kept in the association offices. Government experts test the cattle for disease. The farmers must follow their recommendations in caring for their cows and for the milk. A dairy farmer is a very busy man, and he must also be a very careful man.

General Farming in the South

If this book had been written twenty-five or thirty years ago, it would not have had a section headed "General Farming in the South." It would probably have had "The Cotton Belt" as a heading and treated the South as a land of specialized farming.

Changes in the land of cotton. Once upon a time the South was truly a land of cotton. Southern farmers raised food for themselves, mainly corn; but they used most of their land for cotton. That was a long time ago, before the days of scientific farming. As soon as a science of agriculture really developed, the scientists began to advise southern farmers to grow less cotton and use more of their land for other crops.

Experts in various subjects pointed out the same need. Food scientists said that the

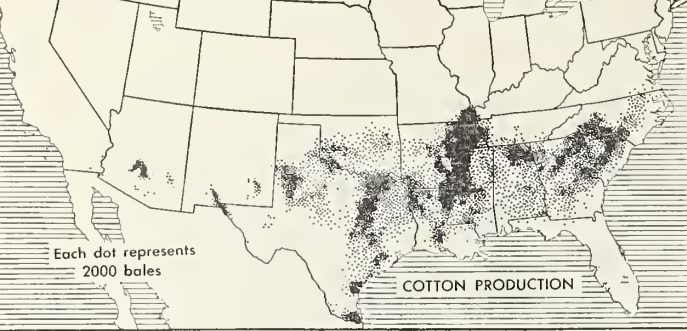
southerners needed more vegetables and more dairy products in their diet. Soil scientists said that cotton and corn, both row crops, were ruining the soil of the South. The danger of erosion is even greater in the South than in the North. In the North the soil is frozen for several months of the year. At least during the winter erosion is stopped. Besides being damaged by erosion, southern soil was also losing its fertility because the same crop was grown on so much of it year after year, without rotation.

Other experts pointed out that people are much safer when they have more than one crop to sell. Every crop has bad years and good years. An early frost, too much or too little rain or rain at the wrong time of year, too little sun when the cotton was maturing—any of these might cause a crop failure. A farmer who had only cotton to sell would get very little money that year because he would have very little cotton. If the year was an especially good one for cotton, the farmer still might get very little money. In that case the price of cotton would be low because so much would be available.

At about the time that people were beginning to understand these things, a real disaster came to the cotton industry. This was the coming of the boll weevil, an insect that lays its eggs in the cotton boll. The grubs that hatch out of the eggs live in the growing cotton boll and destroy the fiber. The insect came from Mexico early in the twentieth century and spread slowly over the entire cotton belt.

Probably you have read the story of the boll weevil. The United States Department of Agriculture and the state departments of agriculture went to work on the problem of controlling the insect. They experimented with poisons, varieties of cotton, careful timing of the crop. They found out where the weevils spent the winter and how to destroy them when they were hibernating.

Some people seem to think that the boll weevil was the whole reason why the cotton belt became a general-farming region. They



are wrong. The weevil may have hurried the change, but it would have come even if there had never been a boll weevil. It would have come because it meant better farming and a better living for the farmers.

Cotton-belt farmers benefited in another way from the introduction of new crops. They were able to spread their work over the year. Cotton is planted in the spring. It has always been customary to plant more seed than is needed. After the plants come up, the extra plants must be removed. The work of removing them is called chopping cotton. The farmer and his whole family work hard at this job, for it must be done when the cotton plants are just the right size.

After the cotton has been thinned by chopping, it is cultivated a few times to keep weeds from growing. In early summer the blossoms appear. After about two months more the first bolls begin to ripen. Then picking begins. Again there is much work, with the whole family kept busy. The bolls do not all ripen at once, and so the pickers must go over the field several times.

Even a large family cannot take care of a very big field of cotton without extra help at chopping time and picking time. In between there is little to be done. Now suppose the farmer plants only part of his land in cotton—just enough so that the family can do the work in the busy season. Then he can plant other crops that will keep him busy when there is no work to do on the cotton, and none of his time is wasted.

For example, on the map above find the part of the cotton belt that extends farthest northeast, in North Carolina. The dots are rather widely spaced, indicating that this is

not a heavy cotton-producing region. Once much more cotton was grown here. Now farmers grow early spring vegetables on part of their land. The vegetables are harvested before the hard summer work begins. Most farmers raise tobacco. The leaves are ready to pick and cure during the summer, when there is little work to be done in the cotton fields. Next comes the peanut harvest, in the early fall. By the time the peanut harvest is out of the way, the hard work of cotton picking begins.

Now look at the western end of the cotton belt, in Texas. In eastern Texas a band of very heavy cotton production crosses the state from north to south. On the vegetation map, pages 370–371, it is the narrow strip of grassland surrounded by broadleaf forest. Look closely, or you may miss it. It is interesting to notice on the vegetation map how closely the heavy cotton production follows the grassland region.

This region, although surrounded by forest, was grassland because of a difference in soil. It is called the Black Prairie. The “black” refers to the soil, and the “prairie” refers to the natural vegetation. The heavy black soils are good cotton soils. For a great many years nearly all the cultivated land was used for cotton.

Corn was always the second most important crop. You can pick this area out on the corn map, page 82. Many farmers did not try to plan a rotation of crops. Cotton and corn would not be good rotation anyway, for they are both row crops.

Between 1930 and 1940 there was a great reduction in the amount of cotton grown in the South. During those years the farmers of the Black Prairie cut down their cotton acreage very greatly. They began to grow more feed crops, especially sorghums and alfalfa. Along with the increase in feed crops, they began to keep more livestock. Truck crops also helped to spread the work and give the farmers a better and more dependable income. Watermelons, onions, and tomatoes are the principal truck crops.

Farm machines in the South. On the whole, cotton-belt farming is not so highly mechanized as farming in the corn belt. First, much of the South is hilly, and most early machinery was cumbersome and large. It worked well only on level or gently sloping land. On small farms it did not pay. Many northerners think of the South as a land of huge plantations. But if you are a southerner you know better. There are large plantations, of course, but most cotton-belt farms are small. Second, the cotton crop required much handwork at the chopping and picking seasons. If this great cash crop could not be mechanized fully, there was not much reason to mechanize other crops.

Now look at the map on pages 374-375. The population pattern of the South is different from the population pattern of the North. The rural population is dense, but there are few cities. Until recently this pattern was even more noticeable. Most southern cities were marketing and trading centers. There was not much manufacturing, and so there was no great market for food crops.

The South has changed rapidly in recent years, and the change is still going on. The region is becoming more highly industrialized. The industrial population gives the farmers a better market for the more varied crops. Industries also give the people more choice of occupations.

The problem of mechanizing cotton growing is partly solved. For many years inventors worked on a machine to pick cotton. There were two principal difficulties. First, cotton bolls do not all ripen at once. A skilled hand picker takes only the cotton from bolls that are just right. The pickers go over the field a number of times during a period of several months. It was hard to make a machine that would leave the unripe bolls to develop. The machine had to do more than select only the fully ripe cotton for picking. It had to leave the bushes unbroken so that they would go on growing.

The second difficulty was getting a machine that would pull the clean cotton from the bolls without mixing in broken pieces of the outside of the boll, leaves, stems, and other

On many farms, machines now make it unnecessary for whole families to spend tedious hours picking cotton.

U. S. D. A. photograph by Marion Post



trash. Even the most skilled hand pickers cannot pick cotton that is absolutely clean. Some of the plant materials are taken out in ginning. Others reach the cotton mills. The mills have machines for cleaning the cotton; but the dirtier the cotton the less the grower gets for it.

During the 1930's cotton-picking machines were made that worked quite well, but they were little used, partly because the farmer still had to chop cotton by hand. It is possible to make machines that will thin the rows, but it is not possible to make a machine that will select and leave the strongest and sturdiest plants. During World War II, when workers were very hard to get, many cotton farmers began to use picking machines. It is possible that new methods of planting will get rid of the need to chop cotton. The picking machines have already been made much more selective in what they pick as they go through the field. On larger farms it pays to use them, even if they do pick dirtier cotton than skillful hand pickers. It pays farmers to pick the cotton cheaply, even though more work must be put into cleaning it.

Farmers in Other Lands

The world has other regions of general commercial farming. Farmers try to make the best use of their land and their time, as North American farmers do; but because of

differences in markets, methods and crops may be different. We shall look at a few examples.

Pampas farmers. On the map of South America, pages 384-385, find the region called the Pampas. This region resembles the corn belt of North America in many ways, especially the part south and southwest of Buenos Aires. The growing season is longer and winters are warmer than those of the corn belt, but the same crops can be grown. The main crops are corn, wheat, alfalfa, and other feed crops. As in the corn belt, there is much land in pasture. The farmers keep a great many cattle and sheep.

Differences in farming between the Pampas and the corn belt are due chiefly to differences in population. Except for the small area around the mouth of the La Plata River, there is no densely populated industrial region near by as a market. Therefore most products are exported, chiefly to the densely populated areas of western Europe. Pampas farmers grow crops that will keep during the long journey. More than half the wheat, almost two-thirds of the corn, nearly half the mutton and lamb, and more than a third of the beef are exported. In Europe part of the grain is used for human food and part as stock feed. One crop, flaxseed, is grown mainly for export to the United States. Linseed oil, pressed from flaxseed, has many industrial uses.

Farmers on the Pampas of Argentina raise beef cattle to be exported in the form of frozen meat.

Three Lions



Farmers of the corn belt and the Pampas grow the same products. What they do with the products is very different. Differences in population density are the chief reason.

British farmers. Great Britain is the principal market for Argentine meat. That is again a result of difference in population density. It does not mean that Great Britain is a poor place to raise animals. British farmers were the first to try to improve their livestock by the use of scientific methods. More than two hundred years ago they were bringing new forage crops from other lands to improve their pasture and hay. More than two hundred years ago farmers were improving their animals by selection. Some of the world's leading breeds of animals were developed by British farmers. In 1720, Benjamin Tompkins inherited from his father a cow named Silver. He and his family went on selecting the best of her descendants for more than a hundred years and thus developed the Hereford breed of beef cattle. The shorthorn and the Angus are also British breeds. So are the Jerseys, Guernseys, and Ayrshires among the dairy cattle and several breeds of hogs and sheep.

Down to the present time British farmers have grown fine animals for export. Farmers in Argentina and the United States buy them to use for breeding, not for meat.

British farmers can grow fine animals, but they cannot grow enough of them. The country is a densely populated industrial region. It is also a general-farming region in which agriculture is scientific, intensive, and highly mechanized; but the farmers do not grow quite the same products as the farmers of a less densely populated land.

Ukrainian farmers. For a very different kind of general-farming region, look far to the east and find the Dnepr River in the



Courtesy Paul Spann & Sons, Inc.

A champion Jersey cow on the island of Jersey. This island in the English Channel was the home of the Jersey breed.

Soviet Union. Use the map of Europe on pages 386–387. The Dnepr flows through the center of a part of the Soviet Union called the Ukraine. The Ukraine extends from the western boundary of the Soviet Union almost to the Don River, and from a little north of Kiev to the Black Sea. It does not include the Crimean Peninsula. In latitude it extends from about 45° N. to about 52° N.

The United States Department of Agriculture has worked out careful comparisons between the climates of parts of the Ukraine and the United States. During the growing season the climate of the northern Ukraine is much like that of northern Minnesota. The central part, on the whole, is like eastern South Dakota. Much of the southern part is like western Nebraska.

In the northern Ukraine the natural vegetation was a mixed forest of coniferous and broadleaf trees. Toward the south the rainfall decreases, and most of the Ukraine is grassland. Over the greater part of it the grass was tall and thick, as in the prairie region of the United States.

When Russia became the Soviet Union, it was a land of peasant farmers. The Russians set out to industrialize the country and make their farming scientific. They thought their huge country should be self-sufficient. It should not have to depend upon imported goods to meet any of its needs.

The Soviet Union has vast areas of good farm land, but most of it is quite far north. There is not much land on which to raise tropical, subtropical, or even warmer middle-latitude crops. To meet the problem, the Russians put their scientists to work.

The scientists experimented with finding the best varieties of crops for the climate and soil, area by area. They worked out efficient techniques and taught the farmers to use them. The government supplies farm machinery for the farmers.

In the northern part of the Ukraine, where the climate during the growing season is like that of northern Minnesota, forage crops, potatoes, and rye are leading crops. Most of the soil is not very good for wheat, but it is grown where the soil is suitable.

Now look at eastern South Dakota on your product maps. The farmers in the central Ukraine grow winter wheat. Much wheat is grown in eastern South Dakota, but it is spring wheat. Corn and potatoes are grown in both regions. In both regions the corn must be varieties that ripen quickly, because the growing season is short. Sugar beets are important in the Ukraine, but not in South Dakota. They could be grown there; but the United States imports most of its sugar from the cane-growing regions of the tropics. The Russians try to raise most of their own,

and so they encourage the farmers to grow sugar beets wherever they can.

The southern part of the Ukraine resembles western Nebraska. The same crops, plus sugar beets and other crops, are grown in the southern Ukraine as in Nebraska.

Vegetable oils are one of the most essential raw materials for modern industry. In the United States large quantities of oil are produced from cottonseed and soybeans, but manufacturers also import vast quantities from the tropics. In Russia sunflowers, poppies, and rape are grown for the oil that can be pressed from the seeds.

None of these is the most surprising crop of the Ukraine. The Russians have tried to make their country self-sufficient in cotton. South of the Caucasus and in Asia they have land with a climate like that of the cotton-producing regions of the United States, but not enough of it. The Russians also grow cotton in the Ukraine—in the part most like western Nebraska and in neighboring regions along the Black Sea. The growing of cotton in the Ukraine depends upon careful selection of varieties and special techniques. The yield per acre is not high, for only part of the bolls have time to ripen. The fibers are short, too. But the astonishing thing is that the Russians do succeed in raising cotton where the growing season is so short.

FARMERS WHO SPECIALIZE

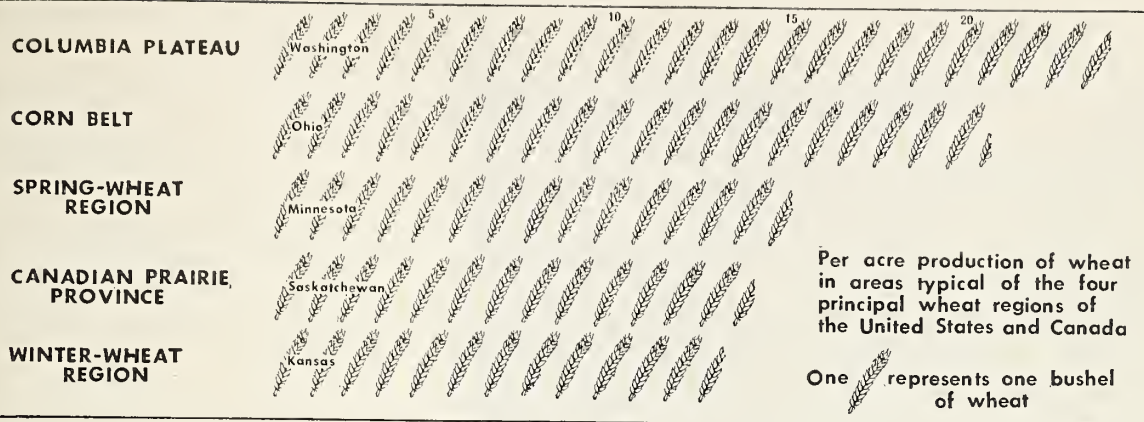
The feat of growing cotton in the latitude of South Dakota and southern Ontario is amazing, but it is not much more amazing than general farming in such a dry region as the southern Ukraine. Check the rainfall with the map on pages 364–365.

Grain Farming

Where the rainfall drops toward 20 inches or below, you do not ordinarily find general farming. In most such regions farmers specialize in the growing of small grains. In the

Soviet Union the grain regions lie to the east of the general-farming regions. In North America they lie to the west.

Farmers in the wheat belt. You remember, of course, that wheat is a grass, and that the great wheatlands of the world were once grasslands. Many people think that these grasslands, with 20 inches of rain or less, must be the best places for wheat. This is not true. Wheat may be spoiled by too much rain at harvest time, but it grows best with more than 20 inches in a year.



A good test is the yield per acre. Look at the graph on this page. The highest yield of wheat per acre is on the Columbia Plateau. After that comes the yield in the corn belt, of which Ohio is an example. Then comes the spring-wheat region, with Minnesota and Saskatchewan as examples, and last of all the winter-wheat region, with Kansas as an example.

This brings up another great geographical generalization that is worth learning. In any region, crops that have a smaller range tend to crowd out the crops that have a wider range. Wait! Don't worry about understanding that statement until you see how it applies to wheat. Corn-belt land will produce more wheat to the acre than wheat-belt land will produce. But corn-belt farmers have a choice of many crops, and so they use only a little of their land for wheat. The drier wheat belt is beyond the range of many corn-belt crops. Farmers in the wheat belt do not have so many choices, and so they use a large part of their land for wheat.

You can easily find the wheat belt on the map on page 82. Probably you know why there is a break across Nebraska. South of this break is the winter-wheat belt. North of Nebraska winters are too cold for wheat to remain alive. There spring wheat is grown. It is planted in the spring and harvested later in the summer.

The wheat belt was settled late. Few settlers went there to farm until after railroads

had reached the region. Wheat is a heavy, bulky crop, but it is a commercial crop and must be sent to market. Therefore a wheat region must have very good transportation. Check the settlement of the wheat region on the historical maps, pages 376-377.

As railroads were built, farmers flocked to the wheat region. Land was cheap and settlers bought large farms. Many of them got land free from the government. They needed large farms, for they could not get much return per acre. Suppose a farmer grows ten bushels of wheat to the acre and sells it for a dollar a bushel. He must buy seed and equipment. He must hire help. An eighty-acre farm would not give him a very good living. He needs a farm of several hundred acres, at least.

By the time the wheat belt was settled, the binder was in general use for harvesting grain. Combines were invented while settlement was going on. Gang plows, turning more than one furrow at a time, soon followed. Improvements were made in equipment for preparing the seedbed and planting the grain. The wheat farmers needed the machines to cultivate their large farms. Today wheat-belt farms are almost wholly mechanized.

A wheat farmer must know his land and its needs. These depend on soil and climate. Differences in soil call for differences in preparing the seedbed and planting the wheat. Climate determines planting and harvest time. If the farm is in a dry and windy

area, the farmer must try to prevent wind erosion. If he is not careful, his wheat field may blow away as dust before the wheat has grown enough to hold the soil. To prevent this, some farmers carry on what is called trashy cultivation. That is not an insult. It is sometimes smart farming. Instead of using a plow that turns a furrow and leaves clean, soft soil on the surface, the farmer uses an implement that merely stirs up the surface, leaving last year's stubble mixed with the topsoil. The stubble, or trash, helps to keep the soil from blowing. Leaving ridges across the field also helps.

New kinds of wheat. As you know, wheat has been grown for a very long time. It was one of the first crops cultivated. Before there were any written records to tell us about it, wheat was carried from its home in southwestern Asia westward as far as western Europe and eastward as far as China. In its travels over the world, many varieties developed. Some were suited to one kind of climate and some to another.

When English settlers came to America, they brought their English wheat with them. The varieties they had were suited to the English climate, but most of these varieties did not produce so well in the new land. After a few years of selection, however, some of them developed strains that were at home in America. For example, a variety called Red May is grown on about half a million acres from Indiana to Missouri. This is believed to be the same as a wheat grown in Virginia in colonial times. You need not remember the name, or the other names that follow.

As settlers moved west into drier country, they found their wheat varieties again not very well suited to the climate. In one part of the world farmers had been growing wheat for centuries in a dry region. This region was in Russia, north of the Black Sea, where farmers today are growing cotton under difficulties. They are growing American varieties of cotton. With their cotton varieties,

American farmers are paying an old debt to the farmers of southern Russia.

About 1770, people of a religious group called Mennonites moved from Prussia to southern Russia. In 1873, descendants of these Russian Mennonites moved to Kansas, bringing with them wheat from southern Russia. This variety of wheat proved to be a great success. The United States Department of Agriculture sent men to Russia to find other varieties suited to the dry lands of America.

The variety brought by the Mennonites is called Turkey wheat. It is now grown on more than twelve million acres of land in the United States, mostly in Kansas, Oklahoma, and northern Texas. It is also grown in Montana, Idaho, and on the Columbia Plateau in Washington and Oregon.

In 1912, a Kansas farmer found a few heads with black hulls in his field of Turkey wheat. They seem to have been a variation that appeared naturally from the Turkey. The farmer saved them and developed a strain called Blackhull that now grows on more than eight million acres in Kansas, Colorado, Oklahoma, and Texas.

The first settlers in America had brought winter wheat from Europe. When settlers moved into a region where wheat could not live through the winter, they simply planted their winter wheat in the spring. Some of it grew and some did not. Thus by selection they got varieties of spring wheat.

A few other varieties have stories worth telling. Early in the nineteenth century, a new kind of wheat appeared in southern Poland. It must have been a variation from a kind already grown there. About 1840, a shipload of the wheat was sent from Danzig to Glasgow in Scotland. A man in Glasgow gave a small sample to a friend named David Fife, in Ontario. Fife planted the wheat in the spring. It was really a winter wheat, and only one head ripened. Fife saved the seed from the one head and planted it. From this one head came the Red Fife variety of wheat. In time it was grown over much

of Canada and the spring-wheat region of the United States.

Red Fife is not so widely grown as it once was, but it has distinguished descendants. About 1890, scientists of the Dominion Department of Agriculture at Ottawa crossed Red Fife with a wheat from India. They named the hybrid wheat Marquis. They grew it for several years and selected the best seeds. In 1907, they sent some to Saskatchewan for testing in the Prairie Provinces. It grew well and is now widely grown in the spring-wheat region of Canada and the United States, especially in the western part—Montana, Saskatchewan, and Alberta. Marquis is not very resistant to a disease called rust. For that reason two other varieties have largely replaced it in the moister part of the spring-wheat belt, where there is great danger from rust. Both are hybrids with Marquis as one ancestor.

These are only a few of the many varieties of wheat grown in America. Others have been brought from Australia. Some have come from North Africa, and many were developed here by crossing and selection.

Of course the wheat belt is not one unbroken wheat field. The farmers get some of the benefits of rotation. Besides wheat, they grow forage crops, especially several kinds of sorghum. They also grow oats, rye, barley, and a little corn as feed. Much land is in pasture, for the wheat-belt farmers keep many cattle.

Wheat farmers settled first on the prairies. Those lands of tall grass became a region of general farming, as more was learned about them. The wheat belt moved farther west. Most people think it moved too far west during a series of rainy years. Climate usually goes in cycles. There will be a series of wet years, then a series of dry years. During a



Soefoto

A Russian scientist shows scientists from the United States new varieties of wheat that have been developed in his country.

cycle of wet years farmers moved farther and farther west. On the rich, new grassland they grew huge crops of wheat. Then came a series of dry years and the farmers at the western edge of the wheat belt were in trouble. There was not enough rain for wheat. Most of them moved away.

Then, years later, came another rainy cycle. Again farmers moved out beyond the region which has enough rain to be safe even in dry years. Then again came dry years—the great droughts of the 1930's. You have probably heard people talk about them. They were more than just a series of years too dry to ripen the wheat. The land itself began to blow away. The plowed topsoil turned to dust. It piled up like snowdrifts, almost burying houses, fences, and roads. Before the west winds it flew through the air in dust storms that darkened the sky far to the east over the corn belt.

Sadly, many of the wheat farmers began to move away from those driest wheatlands. By thousands they moved to the west coast, looking for work. Those farmers were on *marginal* lands; that is, they were on the margin, or edge, of the land that may be farmed profitably. Farmers need to be reasonably sure of a crop every year. On the marginal lands they could not be sure. Experts believe that these lands should be used for grazing, like the still drier lands farther west. And that brings us to another story.

Commercial Herdsmen

In North America dry grazing lands extend from the western margin of the wheat belt to the Coast Ranges and Cascades. There are mountains and irrigated valleys to break the arid grassland, but most of the land has no use except for grazing. In South America the largest area of such land is Pata-

gonia, in southern Argentina. In South Africa there are grazing lands where the climate is too dry for grain. Australia has the largest area of such lands in the world. Use your climatic maps to compare these lands with the lands of the nomadic herdsmen. Rainfall, of course, is most important.

If these grazing lands had been settled a thousand years ago, they would undoubtedly have become regions of nomadic herding. Instead, they were settled less than a hundred years ago. They were settled by people with a high standard of living and no tradition of nomadic herding. The settlers expected to have homes that stayed in one place, and they did not come until good means of transportation had been developed.

Cattle on the range. In your study of American history you probably learned how the drier grasslands were settled. A hundred years ago people were crossing the dry grass-

Cowboys drive cattle to market from the dry grasslands of Australia. They follow planned stock routes. The routes are carefully laid out so that the animals will find grass and water every day.

Courtesy Australian News and Information Bureau



land in covered wagons on their way to the Pacific coast. The land between was just something to get over as fast as they could, before the oxen and horses starved or died of thirst on these dry lands.

Settlers came during the 1870's and 1880's. Within that twenty-year stretch almost the whole grassland was divided into ranches. The first ranchers came with the building of the railroads. Check with the historical maps on page 377 for railroads and population growth. Texas ranchers drove cattle north from Texas for shipping by train. The cattle found enough grass to eat on the way. The cowboy drivers planned the route so that the animals they were driving would have water when they needed it.

These first cattle drivers found the plains such a good place for cattle that some of them herded their animals on toward the north. Many of the herds traveled all the way from Texas to Canada, grazing as they went. The animals grew and fattened as they traveled. At the end of the trip the cowboys loaded the cattle into freight cars. The animals would be sold for meat in eastern markets.

That long drive northward sounds very much like nomadic herding, doesn't it? It differed in essential ways, though. The herdsmen did not take their homes and families with them. They did not expect to spend their lives wandering over the grasslands. They did not expect to raise animals as they traveled. Their herds were made up of animals almost ready for market. Herding the animals on the long drive was a job the cowboys were hired to do. It was not a way of living. Do you see the difference? In another time and another culture it might have developed into nomadic herding. As it was, it developed into ranching.

At the time the grasslands were settled, they belonged to the governments of the United States and Canada. Anyone was free to use them. Cattlemen brought their herds into an unsettled region. As the center of a ranch, they picked a spot beside a creek

or pond or water hole. There they built a ranch house and other buildings. Although the cattle often grazed over a very large area, the ranch buildings remained the home of the owner and his cowboys.

When more cattlemen came, there were many quarrels over the range, as the open grassland was called. There were quarrels over water, too. It became necessary for the cattlemen to buy land and fence it.

Today ranches are still large. Some of them cover thousands of acres. Each animal needs from four or five to twenty or more acres, depending upon the amount of grass. The population is sparse, as you see on the population map. By this time you should be able to explain why. Be sure to study the population pattern on the map on pages 374-375. Towns are small and widely scattered. There is no close network of railways. Most of the railroads cross this region on the way to somewhere else.

Look at the beef-cattle map on page 83. Where do you find the most cattle? If you got the right answer to that question, you may be wondering why the drier lands are called the cattle country. There are far more cattle in the corn belt.

There are more cattle in the corn belt than in the cattle country. There are more cattle in the wheat belt than in the cattle country. You must think of land use to see why the arid land is the cattle country. Most of this land is used for grazing cattle; therefore the West is cattle country.

The typical rancher has a large herd of cows belonging to one of the beef breeds. They are heavier and more solidly built than dairy cattle. He does not milk the cows. They would not give much milk if he did milk them. A cow has a calf every year, usually in the spring. Those calves are the rancher's crop. The length of time he can keep them depends upon how much feed he has. Many ranchers sell the calves when they are a year old or a little more. Corn-belt farmers buy a great many of them and finish raising them. The corn-belt farmers have plenty of feed.



U. S. D. A. photograph by Hufnagle

A rancher has increased the number of animals his land will support by irrigating it and planting nutritious grasses.

Their corn and forage crops are turned into beef, which is worth much more money.

Other ranchers keep the calves until they are full grown. They may sell the animals for beef just as they come from the range. Such animals are called grass-fattened. Corn-belt farmers also buy some of these full-grown, or nearly full-grown, animals. After feeding them grain for a few months, the farmers can sell the animals for much more than they paid for them.

A good many ranchers are able to fatten their own cattle. They may have land that can be irrigated so that it will produce grain, or they may have land that will produce grain without being irrigated. They may even buy grain.

There is no need to tell you how cowboys work, for you have read the stories over and over. You have seen cowboys in moving pictures, too. Tending cattle is probably less romantic than it used to be, but cowboys do still ride the range. They still round up the cattle for branding in the spring and for sale in the fall. But now, when you think of a cowboy, you also have to think of him as going to town on Saturday night in an automobile, and you even have to think of him as riding a tractor sometimes to plow the land for sorghum or for alfalfa.

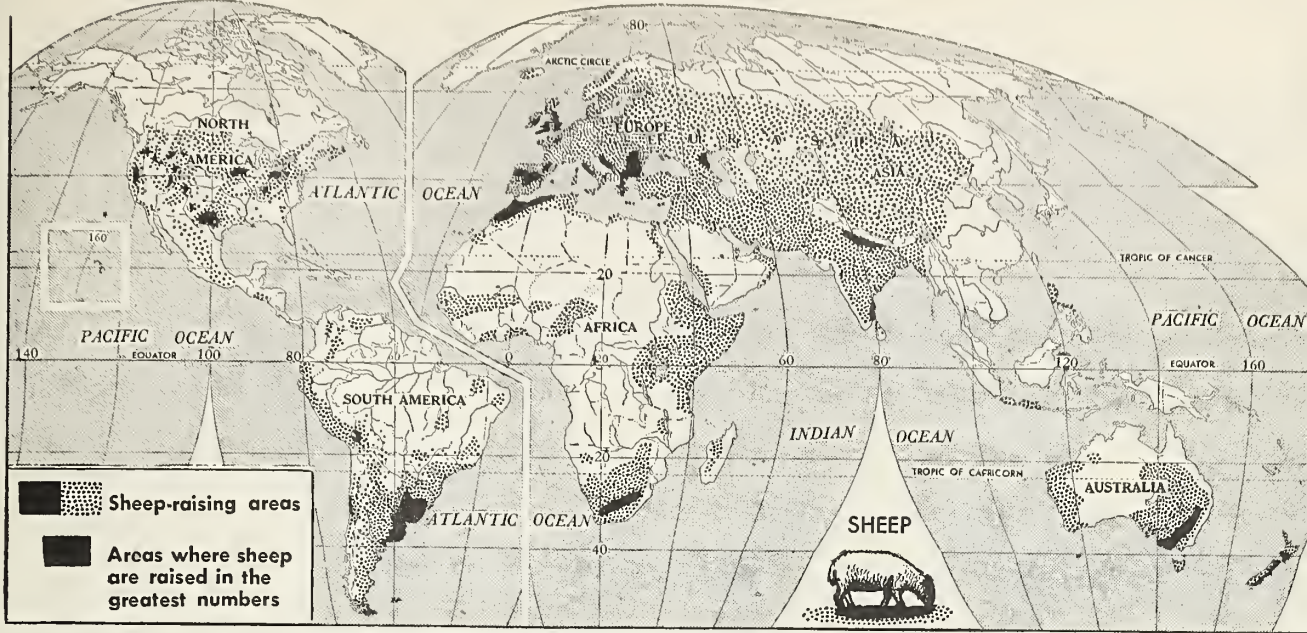
Cattle raising in the West is a kind of specialized commercial farming. It is specialized to use the limited resources of a dry land. Lines from a song express the feelings of westerners about their land: "I would not exchange my home on the range for all of your cities so bright." It seems wrong to say that such beautiful country is poor in resources, but it is. The drier land of the West is a wonderful place to live, but only a few people can make a living there.

Sheep ranchers. Cattle are not the only animals kept on western ranches. Look at the sheep map on page 101. Over the eastern part of the country there are many dots. Thousands of farmers keep small flocks of sheep. They shear the sheep, but selling the lambs for meat is a more important source of income.

Now look at the West. The dots are in spots and streaks, as if someone had dipped a brush in ink and splashed it on the map. Most of these streaks represent valleys in mountainous country. Where grass is too short and scattered for cattle, you are likely to find sheep. You are likely to find them where bushy plants take the place of most of the grass. You are especially likely to find them where the land is rocky and broken. Sheep can eat shorter grass than cattle and can browse on plants that would not be nourishing enough for cattle. They can travel over rougher country, and they can climb better. They can get along with less water. Thus they can use land that would not be suitable for cattle.

Sheep ranchers come a little nearer being nomadic herdsmen than cattle ranchers do. They are not nomads themselves, however. They hire herdsmen to be nomads—or near nomads—for them.

Suppose you are riding through the West in a train or an automobile. Far away at



Sheep-raising regions of the world.

the foot of a slope you see a spot of white. It is a shepherd's wagon. A curl of smoke goes up from the wagon. The herder is cooking his supper. A little way from the wagon a great herd of sheep covers the ground like snow. The two brown spots are the herder's dogs. One dashes away to drive back a straying sheep. Even from a train window the wagon looks lonely.

During the winter most ranchers keep the sheep near the ranch houses. The sheep graze on the brown plants, but usually the rancher also gives them alfalfa, grain, and perhaps silage. Early in the spring the baby lambs are born. Then comes shearing time. Large ranches may have their own equipment for shearing, but the owner usually hires extra help.

The shearers use large clippers. These are run by electric power if the ranch has electricity, or they may be operated by gasoline engines. A skillful shearer works very fast. As soon as he has finished one sheep, another is brought in. The wool comes off in a solid sheet called a fleece. It looks almost like a sheepskin, but it is just wool with the fibers tangled together.

After they are sheared, the sheep are turned over to the herders, two or three thousand to

a man. A herder has dogs to help him, usually two. He also has a wagon to be his home on the range. A camp tender hitches horses or perhaps a truck to the wagon and pulls it to a spot surrounded by good grazing land. There must be water near by.

The herder knows about how long the pasture will last for the sheep. He arranges to have the camp tender come and move his wagon before the grass is all eaten up. The camp tender also brings supplies for the herder now and then.

As the summer goes on, the herder probably moves the sheep into high mountain valleys. When the trail gets too steep and rough for the big covered wagon, the camp tender leaves it behind and carries all the herder's equipment on pack horses. Then the herder lives in a tent.

Much of the rougher mountain land in the West belongs to the government. This public land is the summer grazing ground of a great many sheep. Their owners pay the government for the right to use the land.

When sheep ranching began in the West, the sheep were kept mainly for wool. Now the ranchers get a large part of their income from the sale of animals for meat. The improvement of transportation in the West is



Courtesy of the New Zealand Legation, Washington, D. C.

Sheep resting and grazing add to the beauty of a typical New Zealand mountain scene.

partly responsible. Lamb has also become a more popular food than it used to be.

The largest part of the world's wool comes from lands that are still more newly settled than the western part of North America. The picture on this page was taken in New Zealand, where there are far more sheep than people. New Zealand farmers ship meat from their sheep to England, but they also produce some of the world's finest wool.

Australia produces more wool than any other country in the world. It has land like the arid grazing land of western North America, and it has vastly greater areas of such land. Compare the two continents on the climate and vegetation maps. Australia is hotter than most of North America. The higher temperature causes more of the water to evaporate before plants can use it. A very large part of Australia is too dry for farming. Part of it is even too dry for grazing, but there are thousands of square miles of grassland on the continent.

Australia is a cattle country, too, but it has almost nine times as many sheep as it has cattle. It has more than seventeen times as many sheep as it has people. Australian

sheep produce one-fourth of the world's total supply of wool for clothing. The principal sheep country is the area with a rainfall between 10 and 20 inches on the eastern side of the continent. This area is just west of the mountains, with the largest number of sheep toward the south, in New South Wales. Sheep are kept also in the same kind of rainfall region in western Australia.

Farming Irrigated Land

The herding of cattle and sheep is a specialized use of arid lands. Where there is water for irrigation, farmers specialize in another way. You can see the difference on the population map, pages 374-375. On the whole, the population of western North America is sparse, just as you would expect in a herding region. But scattered over the West are small areas of denser population. In addition to the dense rural population, such areas usually have one or more cities.

Irrigated land supports more people. Nearly all the densely populated areas are irrigated land. One resource, water, had to

be added to the land. An example from one area will show you what water can do. In the Rio Grande Valley in New Mexico is a raneh of four thousand aeres. It is not a eattle raneh, as you might expeet if you live in the East; but the owner ealls it a raneh. If you live in the West, you know that any picee of farm or grazing land may be called a raneh. The owner of this large raneh and his hired helpers cultivate the land intensively. Of ourse, they use the most scientific methods of farming.

Before the land was irrigated, no one at all lived on it. It could be used only for grazing, and it was very poor grazing land. A ew needed to wander over twenty aeres or more to get enough to eat. By keeping eattle, two or three families might have made a living on the four thousand aeres. Perhaps twelve people might have lived there. Under irrigation, the same land supports twelve hundred people. There is a whole village made up of the workers and their families. One important produet is cotton. It is the long-fibered variety that eame originally from Egypt, where it was developed in a very similar environment. Sugar beets are raised for seed. Beets are grown for sugar in cooler lands. They seem to store away more sugar where the summer days are cooler; but they do not produce seeds. A beet needs two years to mature. The first year it grows its large root and stores up sugar. Its top is a crown of big leaves. The second year a stalk shoots up in the eenter, flowers, and produces seeds. In the north, the plant would freeze during the winter. It would not live to produce seeds the secong summer. Southern farmers, therefore, grow seed for northern farmers.

The owner of the raneh and the raneh blaeksmith have designed and built their own maehinery for harvesting the beet seed. The

owner also experiments with crops that have not been grown in this region before. If he finds that a new crop is suecessful, other farmers will grow it also.

In the Salt River Valley in Arizona is another great irrigation projeet. There most of the farmers specialize in growing winter vegetables. They are prosperous seientifie farmers who eultivate their land intensively and grow crops year after year. A few years ago seientists discovered the remains of a much older irrigation system in this valley. No one knows much about the people who lived there. The present-day Indians of the valley call them Hohokam—"those who have vanished."

There are the remains of about thirty villages, eadh one a kind of adobe apartment house like the buildings of the Pueblo Indians. Fields stretched out around the villages. The Hohokam lived there for a long time, but there is evidenee that they beame less prosperous as the years passed. Finally they left. Spanish explorers found only ruins of their villages.

The Hohokam were careful and intelligent. Their engineering was good. They laid out

This temporary dam raises the level of water in an irrigation ditch sufficiently to divert it into a field of sugar beets.

Helen Post from Monkmeier



their canals in the right places to bring water to their fields. But they were not scientists. They did not know that irrigated land must also be drained. Or, if they did know it, their tools and skills were not good enough to accomplish the necessary result. Their soil became filled with water. Harmful chemicals were left in it by the water that evaporated. Then the people had to move away. They became the Hohokam—the people who have vanished. When the irrigation system broke down, a well-populated region went back to uninhabited desert. Today, with a new irrigation system, it is again densely populated.

Crops on irrigated land. You know the stories of the irrigated fruit and vegetable regions of California, of the apple valleys of Washington. You have probably read about the great Columbia Basin project, to be irrigated from Grand Coulee Dam. The region that is now poor grazing land is expected to support a million people when the project is finished. You can trace a band of denser population just east of the Rockies, caused in part by water flowing down from the mountains and used for irrigation.

Another irrigated region you can trace on the population map is the Snake River Valley in Idaho. You can also trace it on the wheat and cattle maps. If you had a sugar-beet map, you could trace it on that. Of all the product maps, though, none show the Snake River Valley so well as the potato map. A good many years ago some of the farmers of the valley decided to specialize in potatoes—but not just any potatoes. They developed their own varieties of large, smooth, mealy, white potatoes, which they marketed as Idaho bakers. Now housewives and restaurant chefs buy Idaho potatoes for baking. The potatoes are shipped out by the carload, even as far as New York.

The fruit and vegetable maps on pages 82 and 83 show many spots of heavy production in the West. Most of these areas of heavy production are irrigated land. The cost of

building and maintaining an irrigation system is high. Farmers in irrigated areas, therefore, must make their land pay well. They usually farm intensively and specialize in high-value crops. Fruits and vegetables are such crops.

Crops for Special Markets

The fruit and vegetable maps also show a region of heavy production along the Atlantic coast. The land on the coastal plain is not irrigated. Here there is a different reason why so many farmers specialize in intensive vegetable and fruit growing. The farmers along the coast have a huge market for their products. Look at the population map again, pages 374–375. The purple and red areas on the map mean millions of city people. All of these people need fresh vegetables and fruit to eat. There are other farmers who specialize in dairying and poultry raising for the same market.

On the vegetable map you see many dots across the Middle West. There are large cities here, too, but there is another reason for specialization. A vegetable-processing company, one of the greatest in America, has its headquarters in Pittsburgh. Many years ago this company set up small plants in towns of the Middle West. Then it signed contracts with farmers who agreed to grow vegetables and bring them to the processing plants. Other processors built plants in the same area. Now thousands of farmers grow vegetables for the small canning factories and pickling factories located in their market towns. This is still another kind of specialization for a market.

One whole country, Denmark, has specialized for a market. Years ago Denmark was a poor country. It has sandy soils and a cool, damp climate. It is not a very good country for general farming, but its struggling farmers tried to make a living by general subsistence farming. Then, with the help of their government, they decided to specialize. Their land and climate are well suited to the

growing of pasture and forage crops. It is true that the climate is a little damp for wheat, but it is satisfactory for barley and other small grains.

The resources suggested specialization in livestock. The next problem was a market. Across the North Sea is England, densely populated, highly industrialized, and with many people who can afford to pay a good price for high-quality products. The Danes studied England as a market to find out what kind of bacon, butter, and other products the English people liked best. Then they planned their farming to produce what the English people wanted. The farmers organized coöperative marketing societies, with their own processing and packing plants. There the products were prepared, inspected, sorted, and standardized. Danish products are guaranteed. Eggs are stamped with the date they were laid. If an English housewife finds a bad egg and reports it, the egg can be traced all the way back to the farmer who brought it in. If the farmer is to blame, his coöperative fines him.

Denmark made itself a prosperous country. Farming is scientific. The country has many agricultural schools to educate farmers and young people who will become farmers. Scientific farming alone, however, would not have been enough to make the Danes pros-

perous farmers. Scientific study of a special market and intelligent production for that market were the extra efforts that made all the difference.

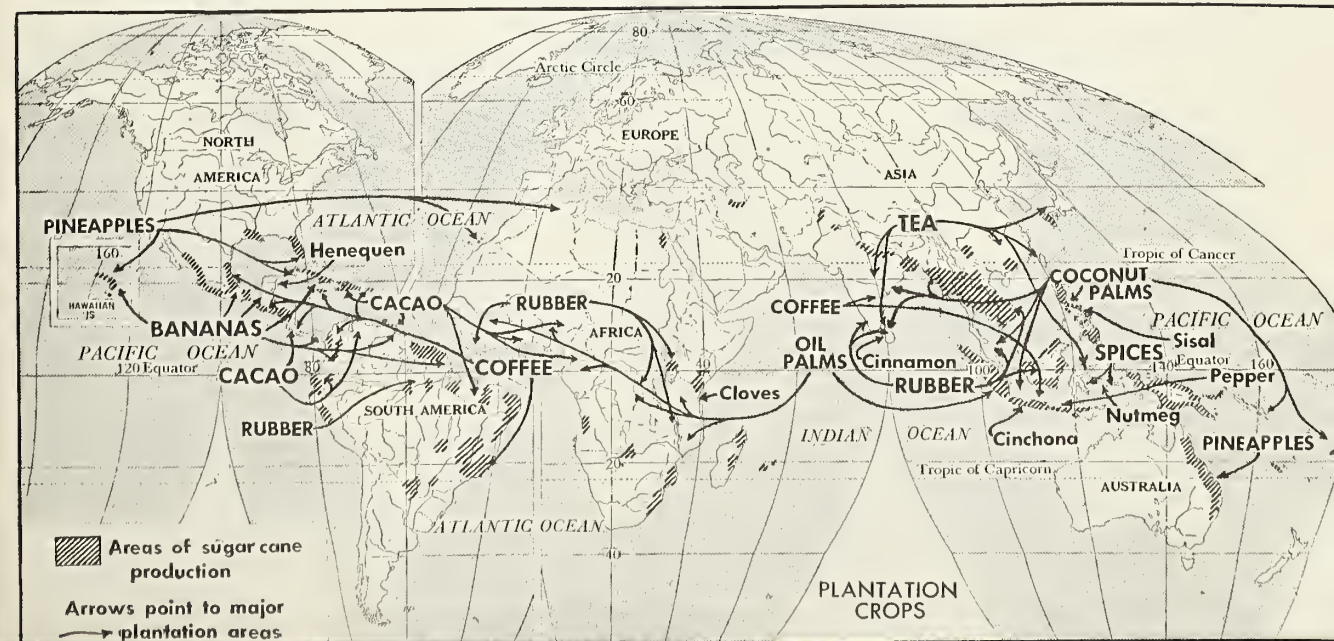
Farmers cannot specialize for a market without good transportation. If you were to drive to Mexico on the Pan American Highway in winter, you would meet truckload after truckload of tomatoes and other vegetables. The trucks are headed north toward the United States. There is a great truck-farming region in Mexico near the highway, but there was no commercial farming in the region until after the highway had been built. Farmers did not begin to specialize in winter vegetables until they had a way of getting the vegetables to market.

Plantation Agriculture

Another kind of specialized agriculture is carried on almost entirely in the tropics. You have seen the tropical parts of the world as lands of subsistence farming. Along with the subsistence farming, there is another and very different kind. This is plantation agriculture. The map on this page shows where some of the world's most important plantation crops are grown.

Plantation agriculture means large-scale specialized commercial farming with a great

Important plantation-crop regions of the world.



many workers, most of them hired by the day like factory workers. A plantation usually produces just one crop. Plantation crops are industrial raw materials such as rubber, vegetable oils, and fibers, or food products such as sugar, cocoa, bananas, pineapples, coffee, tea, and spices.

Growing sugar cane. Sugar cane is probably the oldest plantation crop. No one knows how long it has been grown by the farmers of India. During the Middle Ages, Arabs took it from India to southeastern Asia, Africa, and southern Spain. Then the Spanish and Portuguese settlers brought the sugar cane to the West Indies and South America. There they began to grow it on plantations.

From 1935 through 1939 world sugar production averaged more than 34½ million tons a year. That would be about thirty pounds a year for every man, woman, and child on earth. A little less than a third of the sugar came from sugar beets grown in the middle latitudes. The rest was made from the juice of sugar cane.

Many tropical farmers grow cane for their own use. India, for example, produces more sugar than any other country, but sugar is not exported from India. The people of

India use all the sugar they can raise. For export, more is produced in Cuba than in any other country.

Sugar cane must be processed quickly after it is cut; therefore the fields surround a sugar mill. The plantation usually belongs to the company that owns the mill. If it does not, farmers grow sugar cane for the mill under contract.

The picture on this page shows a tractor plowing a cane field in Africa. In parts of older sugar-cane regions you could see farmers plowing with oxen. Large plantations owned by sugar companies are most likely to be mechanized.

Planting is done by hand. Stalks of cane are planted in trenches. New plants come up from the joints in the stalk. In the tropics the first crop is cut about a year and a half after the cane is planted. In some regions the work of planting is partially mechanized. A machine opens up the trench and carries the cane, but workers must still lay the cane in the trench by hand. This is the method commonly used in the two cane-growing regions of the United States, in southern Louisiana and southern Florida. Cane does not have to be replanted every year. After the stalks have been cut, new plants come up from the stubble.

Sugar-cane plantation in Kenya, East Africa. In this wide field only one man is working, driving the tractor that pulls the plow. With oxen, many men would be needed to do the same work.

Courtesy British Information Services



In most sugar-growing regions cane is still cut by hand. Men with large knives cut the cane as close to the ground as possible. Then they strip off the leaves, which have no sugar in them. Cutting machines are coming into use, however. Inventors worked many years to make a satisfactory machine. It should cut the cane close to the ground even where the ground is rough and even though the stalks do not stand straight.

Cane is heavy and bulky. A plantation needs much equipment for carrying the stalks to the sugar mill. On some plantations the cane is taken to the mill in two-wheeled oxcarts; on others trucks are used. Many large plantations have narrow-gauge railroads running out into the fields.

Most cane regions have plenty of rain. In Hawaii the cane land must be irrigated. This means extra cost to the growers. To meet the extra cost, they need extra production. Little fertilizer is used for cane in other regions, but Hawaiian growers put fertilizer in the irrigation water. Fertilizing pays. The fields produce many more pounds of sugar per acre than they did without fertilizer.

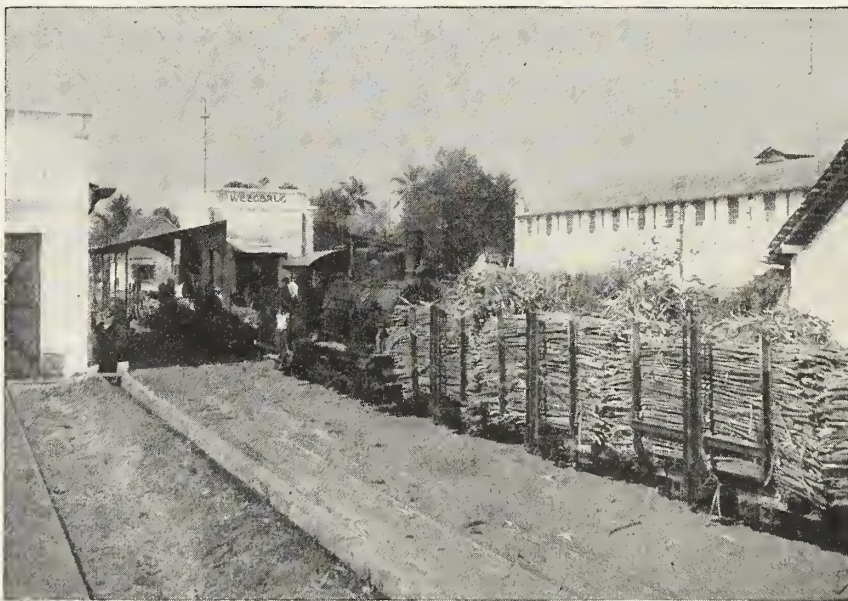
Because of an insect, the sugar growers of Hawaii almost had to give up the sugar industry. Insects are among the great problems in farming. Most insects have insect enemies that keep down their numbers. When a plant is taken to a new region, harmful insects may accidentally be taken with it. Without their usual enemies, they multiply rapidly. This happened in Hawaii.

Scientists hunted over the world to find an insect that would destroy the harmful one



Courtesy The B. F. Goodrich Company

Farm workers in Louisiana cutting sugar cane by machine. The machine is a recent invention, not yet widely used.



Pitz Publishing, Inc.

Open freight cars have carried these freshly cut stalks of cane to the sugar mill on a large sugar plantation in Java.

and save the Hawaiian sugar industry. They finally found an insect in the cane fields of Australia. This is another example of how scientists work for the farmers. Many crop plants have been saved in this way.

Old crops by new methods. You have learned that most of our crop plants have been cultivated for a very long time. All our



Pix Publishing, Inc.

Tea pickers on a plantation in Ceylon. Tea plants were brought from China about a hundred years ago. The hills of Ceylon proved to be an excellent place to grow tea. It is now the island's most valuable export.

A coffee plantation on the highlands of Kenya, East Africa. Here coffee is not far from its native home in Ethiopia, but it was not grown in East Africa as a plantation crop until quite recently.

Courtesy British Information Services



grains and most of our fruits and vegetables were domesticated in prehistoric times. The same is true of the two great fiber crops, cotton and flax. Farmers somewhere in the world have been growing them ever since. Among plantation crops this was also true of sugar cane, as you know. Tea has grown on the hills of China for thousands of years. It is not a plantation crop there. In India, Ceylon, Indonesia, and on the highlands of East Africa, it has been introduced as a crop and is raised on great plantations by hired workers.

Coffee, too, has been introduced into new regions as a plantation crop, but it is not newly domesticated. Bananas were raised by subsistence farmers in southeastern Asia and Africa for a long time. They were taken as a plantation crop to Central America by men from the United States.

Manila hemp was grown by Philippine farmers long before Americans began to grow it on plantations in the islands. Perhaps we should call it abacá. Scientists object to the name Manila hemp. They say it is not hemp and is not grown near Manila.

Two other closely related fiber plants, henequen and sisal, were grown by Indians of southern Mexico. Now they are plantation crops in their homeland and have been taken to the West Indies and to East Africa as plantation crops.

Newly domesticated crops. Most of our crop plants were domesticated so long ago that no one knows just how it was done. Compared with these ancient crops, most of the plantation crops are quite new, and we know their stories. Probably you know how Portuguese explorers found their way to the islands southeast of Asia, looking for spices. Arabs had been carrying on a spice trade for a long time. The plants that produced the spices were wild. Natives of the islands collected the spices from the forests and sold them to the traders.

After a time Dutch traders took the spice business away from the Portuguese. The de-

mand for spices became so great that the wild plants could not supply enough. Then Dutch planters on the islands began to grow the spices on plantations.

Thousands of Pacific islands were fringed with coconut palms. The people of the islands used the nuts for food, the shells for bowls, the fiber for weaving, the trunks for building, and the leaves for thatching. Perhaps they sometimes planted the nuts, but usually there were enough wild trees. Then, as the world became industrialized, the people of the industrial regions began to need more vegetable oils. These oils are among the most important industrial raw materials. The world has never yet had enough of them. Now coconut palms grow on plantations on the islands of the Pacific, in the West Indies, in South America, and in Africa. They are grown for the oil that is pressed from the dried meat of the nuts.

The story of plantation rubber. When Spanish explorers came to America, they found the Indians playing games with balls that bounced. Various explorers, from Columbus on, are given credit for being the first to notice the curious bouncing balls. Cortés probably has the best claim. If you ever travel in Mexico, you will probably be shown the ruins of the ball court where he saw teams of young Indians playing games with those lively balls. Players scored by bouncing the balls through stone rings set in the walls of the court.

The explorers took some of the bouncing material back to Europe with them, and Europeans were amazed at the curious stuff. It looked as if it should be useful, but it was very disappointing. People tried waterproofing cloth with it, but it was sticky in warm weather and brittle in cold weather. Much later an Englishman discovered that it could be used to rub out pencil marks, and that was how it got its English name—rubber. A Scotsman discovered a fairly satisfactory way to make raincoats out of it. Waterproof shoes were made, too, but they were

still sticky in warm weather and likely to crack in cold weather.

An American, Charles Goodyear, made the discovery that turned rubber into a really useful material. He had been experimenting with rubber for a long time. In 1839, he found that if sulfur is added to melted rubber and the mixture is baked, the rubber will remain firm and elastic at any ordinary temperature. The process that he discovered is called vulcanization.

Many uses were found for the new product, but the really great demand did not come until rubber tires were invented. They were used first on bicycles. Automobiles were invented a few years later, and rubber was really on its way.

At first all rubber was gathered from wild plants. A great many plants produce the liquid called latex. If you want to see latex, you can probably find it in weeds of your own region. It is the white liquid that oozes out of the broken stem of a dandelion, a milkweed, or a goldenrod plant. You may try an experiment with it, if you like. Smear a little of it on a leaf and dry it in the sun. Then smear on another layer and another. When the layers have dried, you will have a thin sheet of uncured rubber. Rubber is really prepared in that way, by drying it in layers, either in sheets or in balls on sticks. It was the only way known for a long time.

Rubber hunters scoured the world for plants that produce rubber. They wanted plants that would produce the latex in large quantities. In Africa they found vines, but the vines had to be killed to get the rubber. They were chopped into short lengths. The pieces were set up for the latex to drain out. In other places rubber-producing trees were found. These could be tapped without killing the trees and so were a much more satisfactory source of rubber.

Of all rubber trees, a kind that grows in the Amazon Valley has proved the best. It is nearly always the kind people mean when they just say "rubber tree." Many textbooks for the lower grades tell the story of the

Amazonian rubber gatherers, and you have probably read it at least once. This book is going to tell another kind of rubber story.

In the second half of the nineteenth century the British government was looking for crops for its colonies in southeastern Asia. Someone thought of rubber. A letter was written to Sir Henry Wickham, a botanist who was traveling in Brazil looking for plants unknown in Europe. Wickham was coming down the Amazon. Six hundred miles from the mouth of the river he met a messenger with a letter. The letter told him to try to get seeds of the rubber trees and bring them to England.

He got them—70,000 of them—and put them aboard a British ship. This was quite a feat. A Brazilian law said that rubber trees and their seeds could not be taken out of the country. In fact, Wickham smuggled the seeds. More seeds and plants were smuggled out later by other plant hunters. This kind of smuggling has been done many times, by people of many countries. It has been the means of starting new crops in many regions. People usually think it is very bad when a plant is smuggled out of their own country, and very good when they themselves get a new crop in this way.

Then Wickham took his seeds to London. There agricultural scientists planted them in greenhouses. Not all the seeds grew in this strange environment, but enough of them did. The young trees were sent to Ceylon and set out in plantations. From there they were taken to Malaya and to Indonesia. Plantations of the Brazilian tree were even started in Africa, which has rubber trees of its own.

The rubber planters made many mistakes at first. They were trying to domesticate a wild plant in a strange environment. By selecting the best trees for seed, they finally got strains that were adjusted to the climate and were high producers.

On plantations, the trees are set out in rows and well cultivated. They are tapped carefully, so that the tree is injured as little

as possible. Scientific methods of preparing the latex have been worked out.

Plantations are usually managed by Europeans, but the other workers are natives of the region. Most planters pay their workers whatever wages are customary in the region, or a little more. They usually provide houses a little better than most farmers have in the region, and a little better food. They hire doctors to care for the workers' health, and in some cases they hire teachers for the children. With all these benefits, many people doubt that the workers are as well off as they would be on their own small farms. That is a question to which no one really knows the answer.

There is no question about what happened along the Amazon. It was exactly what the Brazilians thought would happen when they forbade the export of rubber trees. After the plantations became really productive, Brazil lost its rubber business. The rubber gatherers had never been able to supply all the rubber needed. You might think they could have gone on producing at least as much as they ever did, but rubber manufacturers liked the plantation rubber better. Plantation rubber is cleaner and more uni-

form in quality. It is cured in sheets that are easier to use than the balls made by the rubber gatherers in the forests. When manufacturers had a choice, they took plantation rubber every time.

Brazilians talked about having their own plantations of rubber trees, but somehow they never got any plantations started. When Brazil did get rubber plantations, they were laid out by men from the United States working for rubber companies.

The planters found unexpectedly difficult problems. In the forest rubber trees are scattered far apart, perhaps one to an acre. When the planters tried to grow the trees close together on the plantations, diseases spread from tree to tree. Those wild trees just would not do. The planters finally found a strain that was resistant to the disease. Unfortunately, however, it was not very productive. Of course they thought of bringing trees from the plantations in the East, where production had been built up by careful breeding. With these trees their troubles were greater than ever. The trees were now Asiatic plants. Their old home in Brazil was a strange environment to them. Grafting proved to be the answer to the

A plantation worker planting the seed of a rubber tree. When the sapling growing from it is above the ground, a bud from a high-yielding tree will be grafted under its bark. At the right such a bud has grown into a shoot, and the top of the sapling has been cut off. The shoot will become the trunk of the tree.

Courtesy Ford News Bureau

Courtesy The Goodyear Tire and Rubber Company



problem of how to get a high-yielding tree. Young trees are grown from seeds gathered in Brazil. The pictures show what happens. When the young tree is about a year old, a bud from a high-yielding tree is grafted on the stem. After the bud has grown into a sturdy shoot, the top of the original tree is cut off. The grafted shoot becomes the new top of the tree. As it grows larger, it straightens up and covers entirely the scar where the old top was cut off. The top has the high-yielding qualities of the tree from which the bud was taken. The root, from the native tree, is better adapted to the environment.

Sometimes two grafts have been made on the same tree. A disease that kills the leaves attacked some of the plantation trees. The planters found a wild variety that did not get the disease. They started trees from seeds to produce roots. Then they grafted on buds from Asiatic trees for their high production. When the grafted trees were growing well, they grafted a bud of the disease-resistant kind at the top of the trunk. They then had a tree with roots of one kind, a trunk of another kind, and a top of a third kind. The trunk produces the latex. Even when it draws its nourishment from the soil through the roots of one variety and its nourishment from the air through the leaves of another variety, it goes on producing heavily.

Many other stories could be told about plantation agriculture. There is the story of the Dutchman who smuggled cinchona seeds and plants out of South America to plant in Indonesia. Quinine is made from cinchona bark. There are stories about people who started plantations of cacao, bananas, coffee, oil palms, pineapples, cassava, and many more. This book does not have room for all of them. If you are interested, you can find the stories in other books.

From plantations to small farms. Plantation agriculture is the most highly commercialized farming in the world. Most

plantations are run like factories. Workers are hired as factory workers are. Plantations are highly specialized and many are highly mechanized. Factories for processing crops are often on the plantation.

Most plantations are in the tropics. Until European and American planters came, nearly all tropical farmers were peasant subsistence farmers. They did not have either the capital or the knowledge to grow the great quantities of tropical products that the world needs. That is why the great plantations were able to start. If tropical farmers had understood the demand and had been able to grow the tropical products in large quantities, there would have been no need for plantations.

There are indications that the production of tropical crops for world markets may go back, in part, to tropical farmers. In the Belgian Congo a group of Africans went to work on a rubber plantation owned by Belgians. On the plantation they learned how to grow rubber. Then they cleared an area of forest and started a rubber plantation of their own. In Malaya and Indonesia many native farmers have planted a few rubber trees on their own farms. With simple tools they produce good rubber, which they sell to dealers. Many Africans plant oil palms in their gardens and sell the nuts. The shifting cultivators who live in southeastern Asia sometimes plant coffee trees in their fields instead of abandoning them, as they used to do. In West Africa many native farmers grow cacao trees.

All around the world in tropical lands the native farmers are beginning to grow commercial crops that Europeans and Americans have brought to their lands. They are beginning to grow their own crops commercially when those are crops needed by the rest of the world. Some of the native farmers still lack skill. Their products may not be quite so good as those grown on plantations, but the farmers are gradually learning. In many cases their governments are trying to help them learn.

So, to some extent at least, native farmers on small farms are taking over the production of tropical crops. No one knows how fast the change will be made or how far it will go. It will almost certainly be slow. Some crops are better suited to small-farm methods than others. Some require expensive machinery, processing near the field, quick marketing, or more scientific knowledge than native farmers

can get at once. Such crops probably will be grown on plantations for a long time. Certainly the standard of living of the native farmers of tropical regions will be higher when they have more to sell. They are helping themselves when they grow tropical crops that are needed by the whole world. They are also helping people the world over who need their crops.

A WORKSHOP ON FARMING

This Workshop is made up of suggestions for study and tests that will show how much you have learned. You should use it before you begin the study of farming, while you are studying it, and after the other work has been completed. Some of the activities should be carried out by groups, some by individuals. The activities you select for individual work will depend upon your own interests and the advice of your teacher.

Farmers of Your Community

In your community study, it makes a great difference whether you live in the city or in the country. Choose the activities that are best suited to your own community. Do not try to do everything suggested.

HOW DOES YOUR GARDEN GROW?

By the time you have finished this long chapter, your plants should have grown enough to show the results of your experiments. The records of your experiments should answer the following questions:

1. Do plants need light to grow?
2. Can plants grow without a regular supply of water?
3. Does depth of planting make any difference in the length of time it takes seeds to come up?
4. Do all plants of the same kind come up in about the same length of time and grow at about the same rate?
5. How many days did it take each kind of seed to sprout?
6. Which is better for plants, sand or dark soil?

7. How do the new plants of grains and other grasses differ from young plants of other kinds, such as vegetables or clover?

8. Are young plants green before they break through the surface of the soil?

FARMERS OF YOUR REGION

In planning your school garden, you had to find out what crops are raised in and around your community. You might like to make an exhibit of the crops of your region. When you label your exhibits, indicate on each label whether the crop is grown by many farmers or only a few.

By the end of your farm study, you should know enough about farming to talk about it intelligently, even with farmers. Turn your class into an association of farmers and discuss the crops, techniques, and problems of farmers in your region.

A LAND-USE MAP

When geographers make a detailed study of a region, they consult maps that show just how each area of land is used. If there are no such maps, the geographer must make his own. His purpose is not just to find out where crops are raised. After he has found out where, he wants to know why. You cannot hope to make a land-use map of your whole community, but you may be able to make one for a small area.

If you live on a farm, make a land-use map of your own farm. Draw the map to scale. Indicate buildings, lanes, and fences. In each field write the name of the crop your father grew there last year. Then write the name of the crop he intends to grow there next year. If your father follows a definite

rotation scheme, you might indicate the rotation he plans for each field.

HAVE YOU EVER FARMED?

Have you ever raised any farm plants or animals? Every member of the class who has should report on the project. Tell the class how you worked, what success you had, and what you did with your products.

CITY FARMERS

Even if you live in a city, you may have a chance to talk to farmers and find out how they work. Visit a real farm in the country if you can. If you cannot go to the country, you can probably find farmers in the city. Turn to the city occupation graphs on page 380. The column that stands for farming is short, but it is there.

Most city farmers are very highly specialized. They work in the branch of farming called horticulture, which means very much the same thing as gardening.

In vacant spaces at the edge of most cities you will find market gardeners. They grow fresh vegetables to sell to city people. Then there are the florists—not the ones who sell flowers in shops, but the ones who grow them. They usually do their farming in greenhouses. Nearly every city has nurserymen who raise young trees to sell.

Around nearly every city there are part-time farmers who grow some of their own food in their spare time. They range all the way from families with a back-yard garden to families that cultivate several acres.

Talk to such people about their work. Find out what they need to know and what skills they must have. Find out about 4-H Clubs near your community. Invite some of the members to your school for a party. You will be amazed at how much they know about farming. You can probably get in touch with a 4-H Club by writing to the superintendent of schools in a near-by county.

FARMING IN YOUR COUNTY

If you live in the country, find out all you can about farming in your county. Invite the county agricultural agent to talk to your class. Suggest that he tell you some of the special problems of farmers in your county and how their methods might be improved.

FARM RADIO PROGRAMS

Consult your newspaper for radio programs planned for farmers. By listening to such programs, you can learn what information is interesting and important to farmers. Those who plan the broadcasts know what kind of programs will please most farmers.

WHAT FARM PRODUCTS COULD YOU BUY?

What farm products are sold in your community? You cannot possibly list them all, partly because there are too many and partly because some are sold in a form you do not recognize. Would you recognize soybean oil in the coating that makes your raincoat waterproof, or jute in burlap bags?

If you can do so without bothering the storekeepers of your community, find the source of some of the products sold. The storekeeper himself may not know, but often fruits and vegetables come in cartons with the address of the grower or packer.

It is fun to read labels on cans and jars. They always tell what ingredients went into the product. Usually they tell where the product was canned or packed.

In clothing stores you may find a label inside a coat that says, "Australian wool." You may find a leather purse labeled, "Made in Argentina." The hardware dealer may be able to show you rope made of Manila hemp and cord of henequen fiber.

Make a list of all the products members of your class have found. If you learn where a product came from, write the name of the place after the name of the product.

When the list is finished, you are ready to have fun with it. Get a large outline map of the world. In the proper places write the names of the products you have found, or draw pictures of the plants, or paste on samples. You need not be too accurate. Any place in the South will do for cotton and any place in Central America will do for bananas. Then draw lines from all the products to your own community. You can dress up the map in different ways. For example, you may use one color for lines from the sources of food products, another for lines from the sources of clothing products.

This activity is a good class project, with different parts of the work done by different students or committees.

A Game with Maps

By the time you have finished the study of farming and learned to use the maps in this chapter, you should be able to make a good score in any of the following games.

A MAP GAME

This is a game you can play with maps. Use the world product maps on pages 116–117, the other maps in this chapter, and the maps and graphs in the Atlas section at the back of the book.

You are to identify each of the ten areas described. The activity tests your ability to do critical thinking, as well as your ability to read maps. In each description the opening sentence is a guide to the maps you should use first. The sentence tells you the kind of region you are to look for and narrows down the possible answers to a very few choices. Additional sentences cut those possible answers one by one until a single region is left that meets all the requirements.

1. A region of general commercial farming, not in North America, but about as far from the equator as the cotton belt. There is heavy production of wheat, corn, and cattle. Rainfall is less than in the cotton belt, and the growing season is longer.

2. A region that produces more potatoes than any other region in the world, although it is an area of general commercial farming. Much wheat is grown, but no corn. The farmers keep many animals. Population is dense, but only a small percentage of the people are farmers. The rainfall of most of the region is 20–40 inches, the growing season is 6–8 months long, and the natural vegetation was broadleaf forest.

3. A large sugar-producing island at the edge of the tropics. Farming is mainly commercial. None of the island has less than 40 inches of rain in a year and part has more than 60. Heaviest rains fall on a highland region at the southeast. The growing season lasts the year round.

4. A region of subsistence farming in which wheat has been grown since ancient times. Corn and cotton are grown, and a few potatoes. Cattle are kept, but no sheep. The population is very dense. Winters are cold and summers are hot. Summer is the season of heaviest rain. The latitude and

growing season of this region are about the same as they are in the cotton belt of the United States.

5. A region of commercial ranching that specializes in sheep. A few cattle are kept also. Wheat is grown at the southern edge of the region. Rainfall is between 10 and 20 inches, with more in summer than in winter in part of the region. Most of the region has hot summers and cool winters. The land is less than 500 feet in altitude, with a mountain range to the east. Population is less than 2 to the square mile.

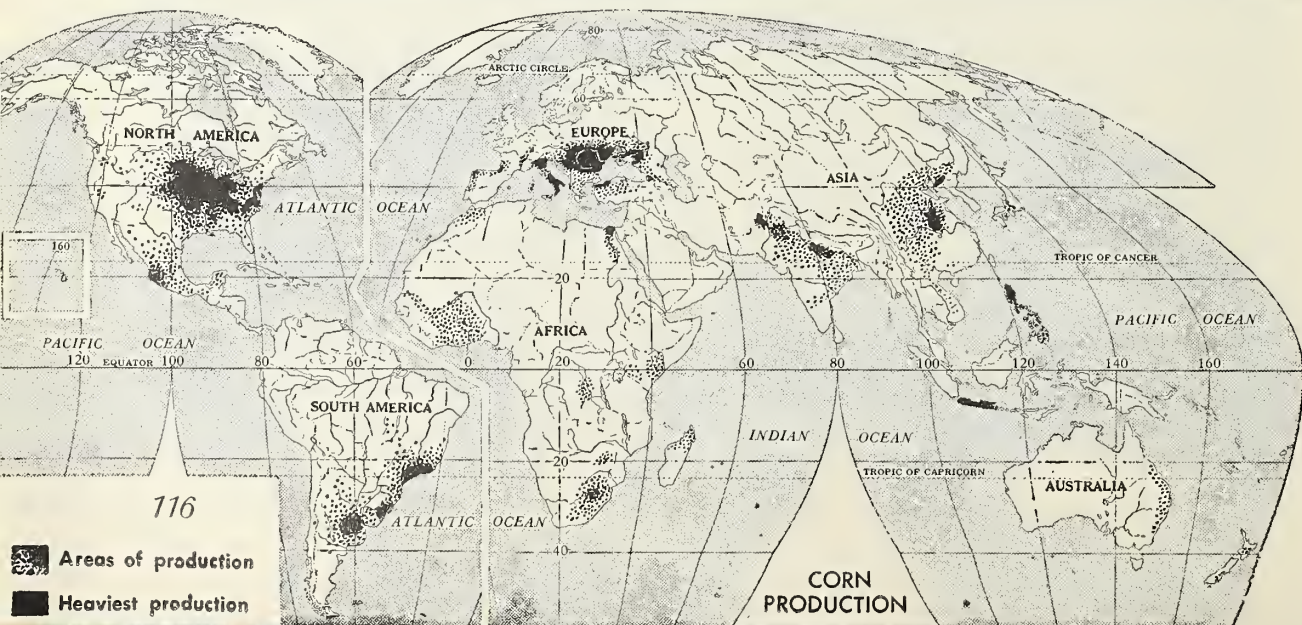
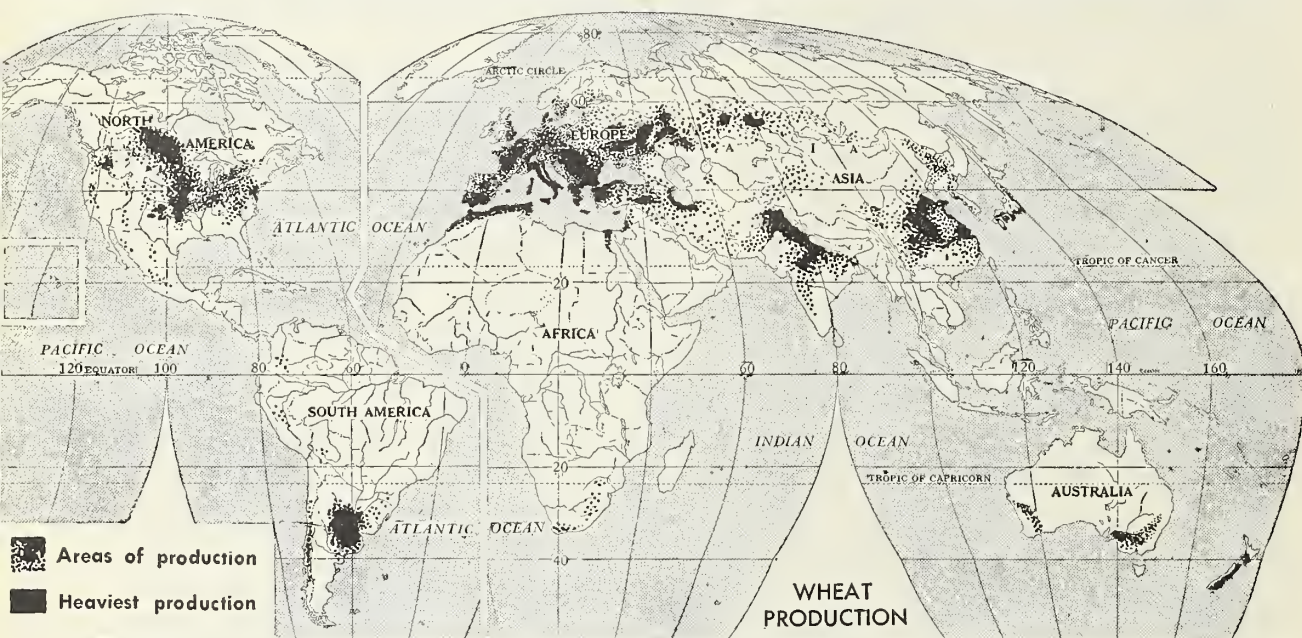
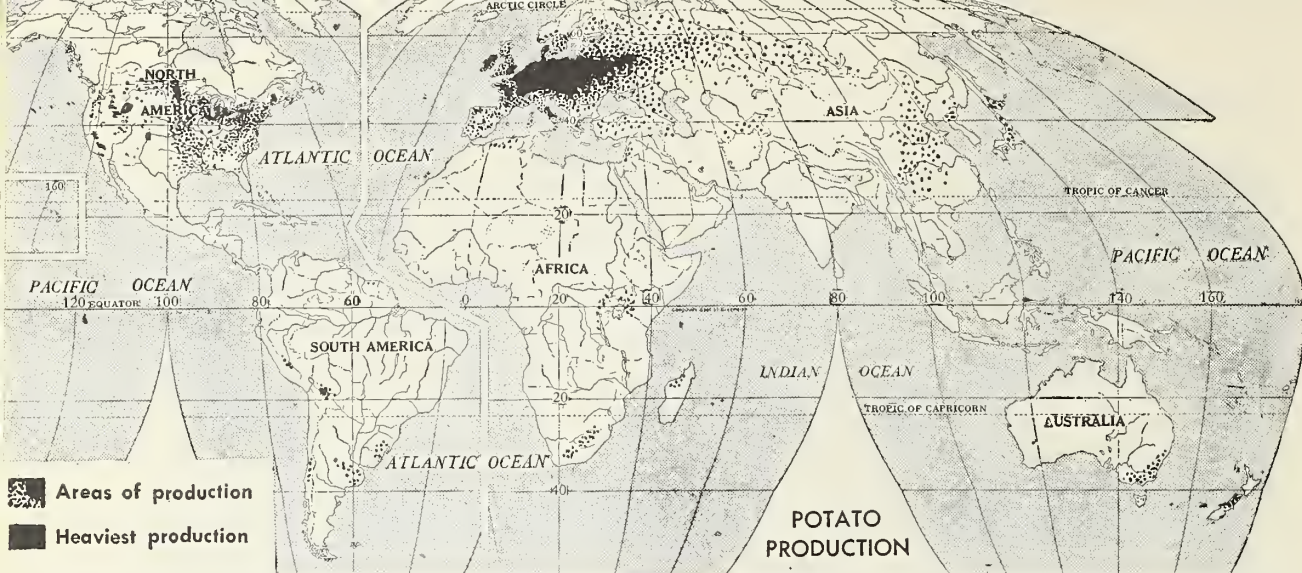
6. A region of commercial farming that specializes in wheat. It lies partly in one country, partly in another. The natural vegetation is grass, and the rainfall is less than 20 inches a year. Most of the region has cold winters and mild summers. No part of the area has a frost-free season of more than 6 months.

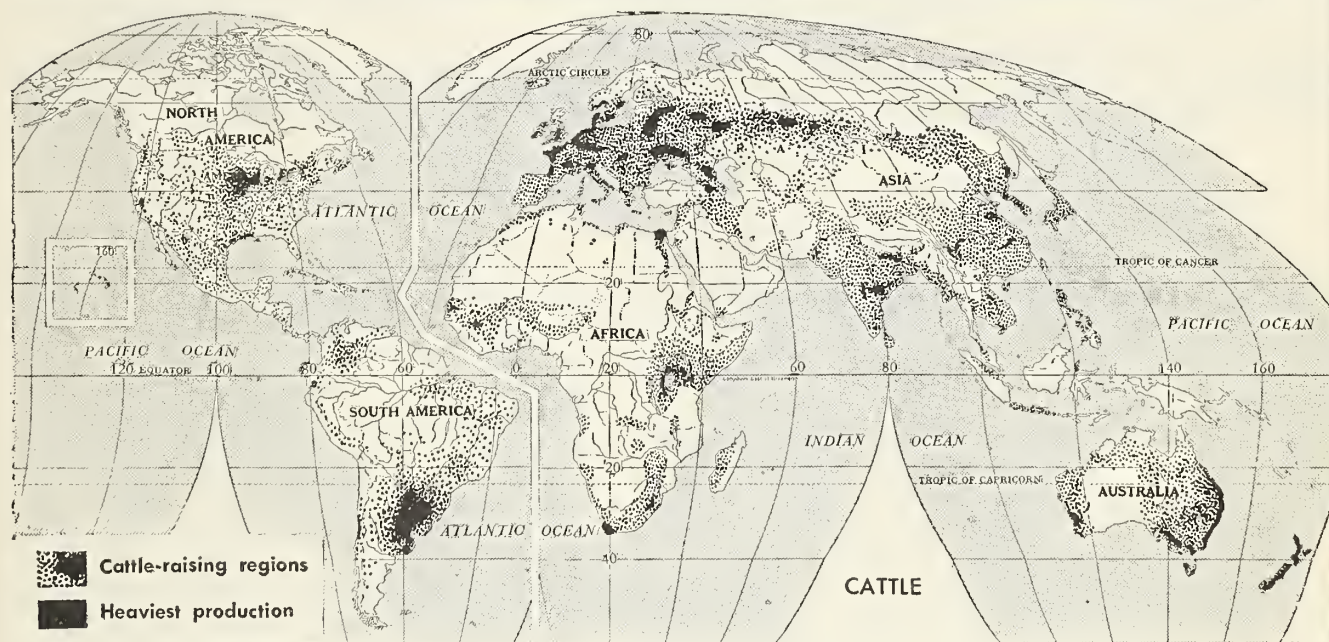
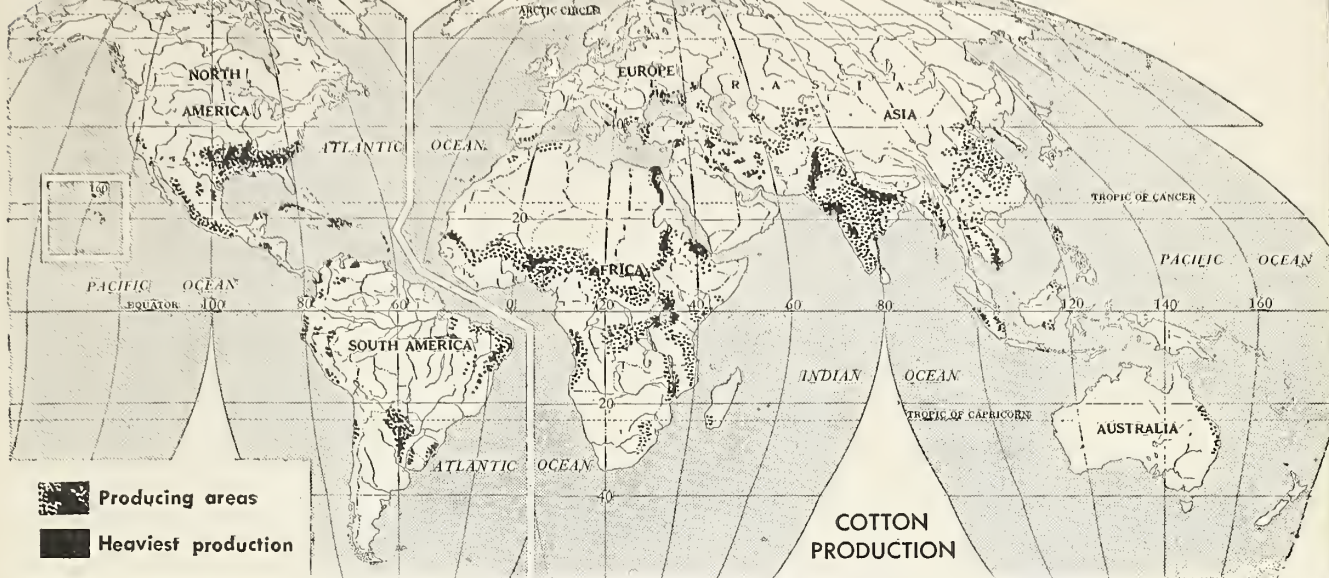
7. A region of nomadic herding crossed by one of the tropics. It is a desert peninsula, with areas in which no one lives at all. Most of it is more than 2000 feet above sea level. Only a small highland area in the southwest corner has more than 10 inches of rain in a year.

8. A tropical region of subsistence farming. It is on a continent that has very little commercial farming except plantation agriculture. The plantations of this region produce rubber and palm oil. The rainfall is more than 60 inches a year. Vegetation is mostly tropical rain forest. The region is the basin of one great river and its tributaries. Population is 2 to 25 per square mile.

9. A region with no farming at all. The natural vegetation is coniferous forest. There is a frost-free season of 2 to 3 months. The population is less than 2 to the square mile. South of it are regions of commercial farming and commercial ranching.

10. A commercial-farming region in which many farmers specialize in growing vegetables, including potatoes. The rainfall is 40–60 inches, well distributed over the year. The growing season is 6 to 8 months long in the south, 4 to 6 months long in the north. The region has hot summers and cool winters. Natural vegetation was broadleaf forest. The region produces little grain. In spite of the heavy production of special crops, only a small percentage of the people are farmers. Much of the region is urban, with two cities of more than a million people.





WORD TEST

You have met a number of new words in this chapter. If you learned them well, you will have no trouble with questions in the paragraphs below.

1. A region has an average yearly rainfall of 30 inches, coming at all seasons. The average is 30 inches, but some years have 40 inches while others have only 20 inches. Is the rainfall unreliable, or seasonal?

2. Thomas Johnson has a duck farm on Long Island. If that statement is not a generalization, find a sentence in this test that is a generalization.

3. A farmer uses machines for nearly all his work. Is his farm mechanized, hybridized, or vulcanized?

4. A farmer in Michigan joined a coöperative marketing association. He agreed to raise the same varieties of peaches, grapes, and strawberries as the other members, so that their fruit could all be marketed together. Was he agreeing to raise his standard of living or to standardize his products?

5. Which of the following commodities are processed and which are manufactured?

wheat	chocolate	milk
cottonseed oil	flour	cacao beans
cottonseed	flax	
cheese	linen	

6. It usually does not pay to farm marginal land. Would you give that advice (a) to a farmer who is moving into a region where the rainfall is unreliable and there is a drought every three or four years, (b) to a farmer who takes great pains to plow close to his fences, or (c) to a farmer who lives far from markets?

7. A corn-belt farmer is planning to buy a tractor, a combine, and a corn picker next year. Which of the following will he be putting into his farm: (a) more capital, (b) more work, or (c) more fertilizer?

8. The Chang and Wang families live side by side in a Chinese village. Both have all the land they can farm without hiring help. Each family has been able to save a fairly large sum of money. The Chang family buys more land so that there will be a bigger farm for each of the two boys when they grow up. The Wang family decides to build a larger and a more comfortable house. Which family is raising its standard of living?

9. A cattleman in New Mexico decided to take a trip around the world by plane. His

plane was forced to land in Mongolia. While he was waiting for the plane to be repaired, he wandered over to an encampment of Mongols and watched them caring for their herds.

Which do you think seemed stranger to the cattleman, the environment or the techniques of the herdsmen?

A GRAPH TO MAKE

On page 31 you saw a graph that told you what percentage of the working population in various countries was made up of fishermen. You can make a similar graph for farmers. Use either picture symbols or bars. The following table gives percentages:

COUNTRY	PERCENTAGE
Bulgaria	80
Peru	52
Canada	25
Australia	20
United States	20
Great Britain	18

Graphs help people to think clearly. Sometimes they bring out facts that could not easily be seen in any other way, and often they correct wrong ideas.

In the graph you have just made, two of the bars stand for countries that are clearly farming countries. Which are they? Two stand for countries that are always classified as industrial countries. Which do you think they are? If you have chosen correctly, you have two countries left that people usually consider farming countries. If someone told you that these are both farming countries, what would you say? How would you use your graph to prove that your answer is right?

ADDITIONAL INFORMATION

The United States Department of Agriculture, state experiment stations, and the Dominion Department of Agriculture in Canada have numerous publications on farming. You can get many of them free by writing for them. Your public library may have some.

Would you like to read something about ancient nomadic herding written by people who saw it and knew all about it? Look in the Old Testament. The following passages will give you interesting information: Genesis 13; 18:1-8; 26:17-22; 37:12-17, 38; 47:1-6.



Lumbermen and Forest Workers

WE CANNOT GET ALONG WITHOUT WOOD

From where you are sitting, how many things can you see that are made of wood? You can probably make a long list. Draw a line under the names of things you can see, and list other uses of wood that you know about. See who can make the longest list in five minutes. Then put your list away and try again after you have finished this chapter. Your second list should be much longer than your first one.

Wood is one of the most important of all our raw materials. Forests are among the most valuable of all natural resources. If we tried to get along without wood and wood products, we should have to give up a great many things we now enjoy.

If all wood and wood products were to melt away today, most of our work and play would be stopped. Our railways would fall

apart, our mines would cave in, most of our tools would be without handles, our telephone and telegraph lines would fall down, many of our houses would vanish, and nearly all our furniture would go with them. Metal industries would have to stop for lack of molds and patterns. Nearly all our books, magazines, and newspapers would be swept away. Business and governments would be thrown into confusion because their records were gone. A great many things we never thought of as being made of wood also would disappear—a good many of our clothes, combs, and toothbrush handles, for example.

It is a good thing that we do depend so much upon wood. Metals and other raw materials dug from the earth are used up and cannot be replaced. Trees are like farm crops. When we use one tree, we can grow

another in its place. People have not always grown new trees to replace the ones they have cut down; but it can be done, and it is being done more and more.

If you have a piece of ground that you can use, plant the seed of a forest tree and watch it grow. Plants are living things, as animals

are. Many trees have very long lives. All your life you can enjoy the beauty of a tree you plant now.

Before you go on, turn to the Workshop which begins on page 140. Now read the Workshop as a guide to your study of lumbermen and forest workers.

CUTTING DOWN THE FORESTS

Forests were the natural vegetation of a very large part of the world. Were they the natural vegetation of your own region? If so, have they been completely cleared, or are some of the forests still standing?

Clearing the Land

To see how much of the earth was once forested, turn to the vegetation map on pages 370-371. Then look at the map on page 119 to see how much is still forested. You see that most of the middle-latitude broadleaf forest has been cleared. The forests that stand today are mainly the tropical rain forests and the coniferous forests.

If you could step back into the past of five thousand years ago, you would find vast forests in some of the regions that now have the best farm lands. All of eastern North America was heavily forested. A great forest of broadleaf trees stretched far eastward from the Atlantic coast of Europe. Skipping the dry lands of central Asia, it appeared again in China.

North of the broadleaf forests lay the great belt of far-northern coniferous forest. South of the broadleaf forest in America was another region of coniferous forest. South of the broadleaf forest area in Europe was the Mediterranean region, which probably had its own kind of forest.

It is time to learn something new about the regions that the vegetation map calls "grass with scattered trees." These regions are not all alike. Some are mainly grassland. Others have a good many trees.

These areas with more trees are often called dry forest or open forest. They have enough trees to make forest products important.

So far as we know, there have always been forests in rainy low-latitude regions. They are the thickest and densest forests in the world. Only small areas have been cleared down to our own time.

In the Southern Hemisphere, south of the equatorial regions, forest areas are smaller than in the Northern Hemisphere. The Southern Hemisphere has little land in the latitudes of northern forests.

The early farmers. The first farmers and herdsmen lived on the dry lands at the eastern end of the Mediterranean. They had no problem of clearing forests, for they lived on grasslands. The first New Stone Age farmers of Europe apparently cultivated the meadows along the rivers. But even with stone axes it was possible to cut down trees. As soon as there were enough farmers who needed land, clearings were made.

If you had traveled through western Europe five thousand years ago, you would have made your way on foot along dim trails through almost unbroken forest. Now and then you would have come to a busy little clearing around a village. Houses and barns were made of logs. Plows and other simple farm implements were made of wood. Firewood was stacked near the houses.

If you had lived five thousand years ago, you would not have been traveling in the far north of Europe. Probably no one lived there at all. The earth had so few people

that no one needed to live in such an unfavorable environment as the great northern coniferous forest. It was not until the later Middle Ages that real settlement began in that part of the world. Gradually much of the southern edge of the coniferous forest in Europe was cleared. In Asia settlement was even slower, and only recently have many settlers gone into the region.

Little is known about the rest of the world as it was five thousand years ago. Probably eastern Asia was covered with forests. In the forests farmers made clearings, as they did in Europe. In southern Asia and other equatorial regions, shifting cultivators no doubt began to make their temporary clearings a very long time ago.

Clearing American farm lands. Everyone knows the story of the clearing of North America. From the eastern coast westward beyond the Mississippi, settlers chopped down the trees to make farm land.

To the early settlers trees were the most difficult sort of weeds to remove from the land. Pioneer farmers and their sons spent every winter clearing new fields. The trees had no value except for home use. Those cut down year by year were used for firewood. If there were too many for that, they were rolled into piles and burned.

As the country became more densely settled, almost every little town had a sawmill. Many farmers spent their winters cutting down trees and hauling logs to the sawmills. Wood was still plentiful and lumber was cheap, but it did begin to have real value. Trees were no longer just something to get off the land as quickly as possible. By far the largest quantity of timber was cut for firewood. All farmers and most town people used wood stoves for cooking and heating.

In the broadleaf-forest region most buildings were made of lumber. On the farm almost everything was built of wood. Near the frame house stood the wooden barn, chicken house, cornerib, pigsty, and other buildings. Rail fences marked off the fields,

with perhaps fences of boards near the house. Even the farm implements, many of them made at home, had much more wood in their construction than those of the present.

In towns and even in cities most houses were frame. Small-town business buildings were often made of wood. Many sidewalks were made of boards. Telegraph and telephone poles were of wood. Yards were enclosed by picket and board fences. Carriages, wagons, and railroad cars were made of wood. Millions of trees were cut for railroad ties.

Cutting Trees for Lumber

The population of the earth grew slowly. For hundreds and hundreds of years there were great forests in Europe, with farm lands cleared between the forests. Lumbering was not carried on as an industry. As a village of peasant farmers grew larger, the people cleared new fields. They used the trees they cut down. They cut a few additional trees when they needed lumber, but they needed so few that young trees took their places. Dead trees and fallen branches supplied most of the firewood. Such cutting and clearing was good for the forest.

Most regions in America had plenty of wood as long as the pioneers were moving through the forest region. Every pioneer farmer cleared his fields one by one. Fifty or sixty years after a region was settled, farmers were still spending their winters getting out logs. The people of the United States used vast quantities of wood, but farmers supplied most of it. They cut it from their farm wood lots in their spare time.

You might call the work of the farmers subsistence lumbering with a little surplus for sale. A farmer kept his wood lot mainly for his own use, but he sold some of the extra wood and lumber. A time came when this method did not supply enough wood for lumber and raw materials. Then lumbering became a business. The forests were cut down, not to clear the land, but to get lumber.



K. S. Brown, Courtesy American Forest Products Industries

This skillfully felled tree avoids injury to its uncut neighbors and to lumbermen in crashing into a forest clearing. One logger remains on the platform where he stood to help fell the tree.

Methods of logging. One of the few tools every pioneer carried with him was an ax. When a pioneer farmer wanted to fell a tree, he chopped it down. He chopped off the limbs and chopped the trunk into convenient lengths. Later, most trees were felled with a crosscut saw. This is a long saw used by two men. One man pulls the saw toward himself, and the other pulls it back. It cuts on both strokes. Lumbermen who cut down trees are called fallers. You do not need to have that word explained. Fallers first look over a tree to see whether it leans or stands straight, whether it is well balanced or the top is heavier on one side than on the other. After they have examined the tree, they decide in which direction to fell it.

First the fallers chop a notch in one side of the tree. This is called an undercut. They begin to saw from the opposite side and work toward the undercut. The tree usually breaks off before its fallers have cut quite through the trunk. It falls toward the undercut because support has been removed from that side of the trunk. The lumbermen try to make the

tree fall where it will not damage uncut trees, where the trunk will not be broken by falling across a rock, and where the log will be easiest to move.

After the tree is down, it must be cleared of branches and cut into logs. Most coniferous trees have one tall central trunk running from the roots to the highest tip of the tree. The side branches are small and of no value. Some kinds of broadleaf trees divide into two or more limbs, each large enough to be made into lumber.

Mechanization. Fallers still swing gracefully back and forth, back and forth, pulling the long saw through the trunk of a tall tree. In many forests, though, felling has been mechanized. The men use a power saw operated by a gasoline engine or a small portable electric generator. The power saw saves the fallers the back-breaking work of pulling the long saw back and forth. It is much faster than cutting trees by hand. It also saves more of the wood. Fallers working by hand cannot cut a tree very close to the ground. A power saw can be used almost at ground level and saves several feet of tree trunk.

Guided by two men, a modern power saw cuts its way toward the chopped undercut which will direct the fall of this tree.

K. S. Brown, Courtesy American Forest Products Industries



Transportation is one of the greatest problems of logging, and here mechanization has been of the greatest help. A log is bulky, heavy, and awkward. It is cut in the midst of a thick forest. Often the forest is in a mountain region where transportation is difficult at best.

The first loggers in America cut trees along stream banks and rolled the logs into the streams. As lumbering moved back from the banks, logs were skidded, or dragged, to the stream. Oxen or horses were used to pull the logs. In the northern forests the skidding was usually done in winter because the logs slid more easily on the snow than on bare earth. If they were to be carried by road, they were loaded on sleds, or on wagons if there was no snow.

Perhaps you remember pictures you have seen and stories you have read of great log drives on swift rivers. You think of swirling timber, dangerous jams, and lumbermen leaping from log to log. Very little of this is done now in the United States. It is necessary to cut timber farther and farther away from the rivers, and there is no longer much need to use this dangerous, uncertain, and wasteful method.

In the South there was no snow to help in moving logs and not many swift streams for floating them. There light railroads were built into the forest. The logs were dragged short distances to the railroad by teams of oxen or mules.

In the Far West all these methods were used, but other ways of moving logs were needed as well. Since most of the forests are on steep mountain slopes, it was difficult to build either roads or railroads to all the places where they were needed. Western streams are apt to be too small and too swift, with too many falls and rapids, to be satisfactory for floating logs. Then, too, many of the trees in the western forests are extremely



Courtesy Caterpillar Tractor Co.

Dragged through the forest by a tractor, these heavy logs will be loaded onto a truck and hauled to a near-by sawmill.

large and hard to handle. They called for quite different logging methods.

The trees are so huge and the country is so rough that logs could not be dragged by animals. This difficulty led to the development of "high-lead" logging. A tall, strong tree, called a spar tree, was topped and was left standing. Then pulleys were rigged high on the standing trunk and a powerful steam engine was set up. A strong cable ran from the engine through the pulleys. The free end of the cable was attached to a log, the engine wound in the cable, and the log was dragged through the forest to a pile. When all the trees within reach had been cut, the engine was moved and a new tree was prepared for the cable. The objection to high-lead logging is its destructiveness. Huge logs are necessarily dragged straight through the forest, regardless of what may be in the way. As a result, young trees are broken down and the whole forest is destroyed.

Many logging railroads wind around through the mountainside forests, but railroad building on the steep slopes is difficult and expensive. Fortunately, the slopes make possible another method of transportation. This is the flume. The flume is a wooden trough, often many miles long. Water from



Forest regions of North America.

a mountain stream is turned into it at the top. The logs are rolled in one at a time and float down to the railroad or sawmill in the valley. In some places straight, steep flumes are greased to make them slippery. No water is used. The logs slide down on the grease.

All the old methods are still in use, but newer methods are rapidly taking their place. Now logs are usually skidded by tractors, loaded by machinery, and hauled on trucks.

Lumbering in New England. The map on this page shows the lumbering regions of North America. Commercial lumbering began in New England almost as soon as the first settlers came. A sawmill was set up at Berwick, Maine, in 1631, and it is not absolutely certain that this mill was the first one. Other mills were soon built beside the swift New England rivers. The rivers furnished both power and transportation.

Timber from the New England forests was exported to England and to the West Indies.

It was used for making barrel staves and clapboards or shingles. Most important of all was its use in shipbuilding. Those were still the days of wooden sailing ships. The fine, tall forest trees made strong keels, ribs, and beams and were especially valued as masts. Although New England continued to export ship timbers, it came in time to build its own ships. Every river mouth had its shipyard or boatyard. Fishing boats, whaling ships, trading and passenger vessels were built along the New England coast.

Most of the timber cut in the early days was white pine, said to be the most useful tree for all purposes in American forests. It grew to a height of 130 to 160 feet and had a diameter of three or four feet. Some trees have been measured that were 250 feet high and more than six feet through. Perhaps you wonder why those statements are made in the past tense. Nearly all the large white pines in New England were cut long ago, and young trees have not had time to grow to such great size.

In New England lumbering was largely a winter occupation. Most of the lumbermen were farmers in summer, but New England, on the whole, is not a very good farming region. The soil is thin and rocky and not very fertile. The growing season is short. Farmers here have sometimes added to their income by finding work for the winter.

Winter was the best time for cutting trees. New England winters are snowy, and the lumbermen depended on the snow for moving their logs. The logs were skidded or hauled on sleds to the nearest stream. In the spring, when the ice and snow melted, the water carried the logs downstream to the sawmills. New England has many small streams that have swift enough currents to carry the logs. At present this method is not much used except for sending pulpwood to paper mills.

While they were working in the forests, the men lived in lumber camps. They slept in a large bunkhouse made of logs or boards. Another building with stoves and tables held the kitchen and dining room. There was a stable for the animals and perhaps other buildings for tools and equipment, depending upon the size of the camp. Lumber camps are still very much the same, except that the lumbering has been largely mechanized and you would see powerful tractors and trucks instead of oxen and horses.

Nearly all the trees cut in New England today are coniferous. Lumbering is no longer important in this section, however. The New England States now produce only about 4 percent of the lumber cut in the United States. Most of it is used for making small wooden articles in the factories of New England towns.

The trees of this section are more valuable for another product than they are for lumber. Smaller trees can be used for pulpwood than for lumber, and the wood need not be of such high quality. After the great trees of the original forests were cut, young trees grew up. Forests of these younger trees are called second-growth forests. Since it takes many years for a tree to grow large, the second-

growth forests of the United States do not have the fine trees of the original forests, but the trees are satisfactory as raw material for the paper mills. New England produces about 14 percent of the pulpwood of the United States.

Lumbering moves westward. New England remained the leading lumber region of the United States until about 1840. By 1850 New York was the leading lumber state. Ten years later, in 1860, Pennsylvania held the first position. The center of the lumber industry had shifted from New England to the Middle Atlantic States.

The Middle Atlantic States have, and always have had, many more acres of broadleaf forests than they have of coniferous forests. Nevertheless, the white pine was the most important tree marketed from these forests, just as it was from the forests of New England. There were two reasons why the white pine was the leading tree cut for lumber in a region which lies mainly in the broadleaf-forest area. First, the broadleaf forests were found chiefly in the land which was best for farming. The trees had been cleared away earlier to make room for agriculture. The rough mountain country and the areas of poorer soil were grown over with conifers, which remained for commercial lumbering. Second, for use as building materials and many other purposes, lumber from coniferous trees is more satisfactory than lumber from broadleaf trees. It is easier to work.

Lumbermen call coniferous trees softwoods and broadleaf trees hardwoods, but those terms do not always describe the wood accurately. To be quite truthful, we should have to say that some softwood trees are harder than some hardwood trees. In general, though, the coniferous trees are softer. It is also easier to get long, straight softwood logs for sawing. Broadleaf trees often divide into several large limbs, but most coniferous trees rise in one straight trunk from the roots to the tip of the crown.

The Middle Atlantic States did not remain the leading lumbering region very long. The coniferous areas were not very large, and the best and most easily reached sections were soon cut over. In the meantime, during the first half of the nineteenth century, settlers were moving rapidly into the region around the Great Lakes.

The Great Lakes region. Turn to the historical population maps on pages 376–377 and look at the northern Great Lakes region, in Michigan, Wisconsin, and Minnesota. In 1840 only the southern edge of Michigan and Wisconsin were settled. By 1870 settlement had moved much farther north, and by 1890 almost the whole region was settled.

The southern part of the Great Lakes region was settled by farmers who cleared the land for farms. The northern part was cleared by commercial lumbermen. They moved into this region after the best timber had been cut in New York and Pennsylvania.

In this section, as farther east, great lumber camps were built. In these lumber camps the Paul Bunyan stories originated. If you do not know these fine myths of the giant lumberman and Babe, his great blue ox, you had better look them up.

For a few years a camp was a scene of great activity. Axes rang in the woods, saws buzzed, and clouds of smoke poured out of the stacks of the sawmills. Then the timber near the mill was all cut, and the lumbermen moved on to a new location. In the forest were left only young trees, too small to cut, and great piles of limbs and brush trimmed off by the lumbermen. If the forest was fortunate enough to escape fire, the young trees would one day be valuable, but not for a long, long time.

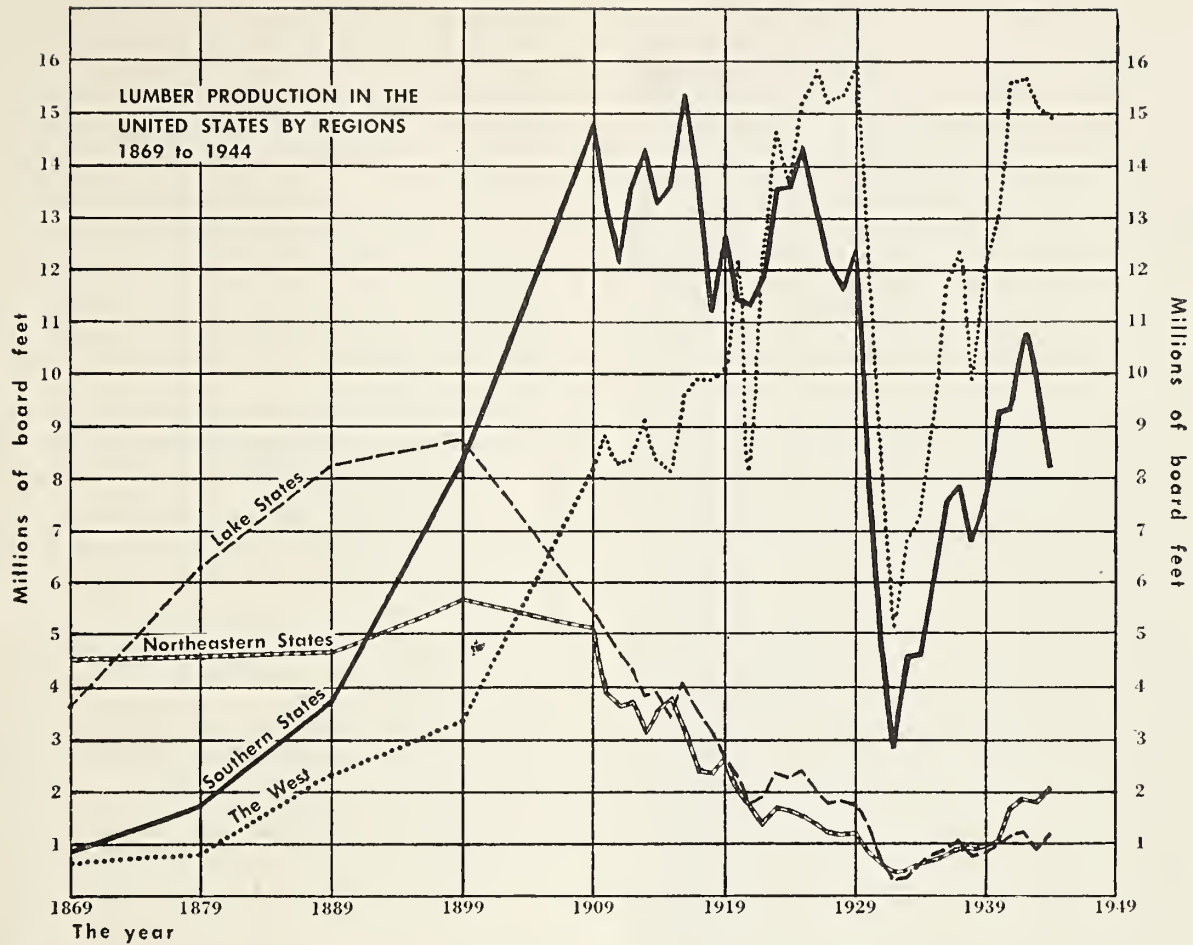
Lumbering is still carried on in the Great Lakes states, but the mills are small, compared with those of sixty or seventy years ago. In a recent year the Great Lakes states produced 3 percent of all the lumber cut in the United States. Their percentage of pulpwood production is much higher.

Southern forests. By the beginning of the twentieth century, the lumber industry had moved to the coniferous forests of the South. Look at the graph to see when the South first produced more lumber than the Great Lakes region. The softwoods cut in the South are longleaf pine, shortleaf pine, loblolly pine, and slash pine. All these varieties have similar wood. You will usually find them grouped together as southern yellow pine or just yellow pine. This refers only to the wood, however. It is not the name of any variety of tree.

In the South the lumbermen had to face new problems. There was no snow to make transportation easy. Most of the rivers are too slow to be satisfactory for log drives. In the woods, the lumbermen used mules or oxen to skid logs over the ground. Then the logs were loaded on trains for the rest of the journey to the sawmill. Special logging railroads ran through the forest in all directions. Small engines puffed up and down the tracks, dragging flatcars piled high with logs.

The peak year for lumbering in the South was 1909. After that year the quantity cut began to decline, but the South is still one of the leading lumber-producing areas of the country. Logging railroads are not nearly so important as they used to be. Many are still in use, but trucks and tractors are replacing them. Instead of oxen and mules, tractors with caterpillar treads drag the logs through the forests.

Coniferous trees do not make up all the forests of the South. They form a wide band along the coast, but even here there are many scattered areas of broadleaf trees. The vegetation map, pages 370–371, shows large areas of broadleaf forest farther north. Check the coniferous area with the climatic maps in the Atlas section at the back of the book. It is in the part of the South that has the heaviest rainfall and the warmest weather the year round. Winters are usually warm, though there is a cold snap now and then in most of the area. On the whole, the



broadleaf-forest areas are cooler and have less rain than the coniferous-forest regions. The soil is usually less sandy and more fertile. Many people think that trees are probably the best crop for most of the coniferous region near the coast.

The South has areas of swampy land in the valleys of the rivers flowing toward the Atlantic and the Gulf. The bottom lands of the Mississippi are the largest of these areas. The swampy areas have a kind of forest all their own. It is made up partly of broadleaf and partly of coniferous trees. Tupelo and several varieties of gum are the most important of the hardwoods. The most valuable coniferous tree of the swamp forests is cypress, called bald cypress because it sheds its leaves in the fall. As you know, most conifers are evergreens.

As in other parts of the earth, most of the region of broadleaf forest has been cleared for farming. Enough of the forest is left to support a hardwood-lumber industry, however. Most of it is in the highlands. In the eastern part of the Appalachian region and on the Piedmont is a furniture-making district using hardwood timber as its principal raw material. The center of the industry is in North Carolina.

The coniferous forests of the South yield another product besides lumber. If you were to visit the pine forests, you would see many trees with V-shaped cuts through the bark and little cups fastened at the lower ends of the V's. A kind of gum called resin oozes out of the cuts and flows down a little tin gutter into the cup. When the resin is distilled, it separates into turpentine and

rosin. Turpentine is used in paint, and rosin has many uses. For example, it is used in paint, varnish, and soap, and to give a smooth surface to paper.

Rosin and turpentine, with tar and pitch, which are by-products of the industry, are called naval stores. The name comes from their early use on ships. Tar was used as a preservative on ropes. Pitch stopped up the cracks between planks. Turpentine was used in paint, as it is now.

Forests of the Far West. The West was the last section of the United States to develop a great lumber industry. The slopes of the mountains facing the Pacific, northward from about 40°, are almost perfect for coniferous trees. Conifers grow best in regions with cool, moist summers and with winters a little below freezing. Here there is no dry season, as in the region of Mediterranean climate farther south. Winter brings heavy rainfall to the lowlands and deep snow to the higher slopes. The soil is soaked with water, the air is damp, the growing season is long, and the whole setting is ideal for conifers.

No doubt you have heard often about the "big trees" of California and seen many pictures of them. Perhaps you have seen the huge trees themselves. The correct name for these trees is sequoia, and they are believed to be the largest and oldest of all living things. The largest one is 272 feet high and 36½ feet through at its greatest thickness. If you measure these lengths on the ground, it will help you to understand the size of this huge tree. Scientists say that it is between three and four thousand years old. The big sequoias grow only on the western slopes of the Sierras, at elevations of 4000 to 8000 feet.

Of course none of the sequoias are cut for lumber. They are too rare and too interesting. Their close relatives, the California redwoods, are cut, however. These trees are huge, although they are not so large as the sequoias. Redwood is very durable and is not damaged by the weather. It has a

pleasing red-brown color and is much used for building, especially in California.

Back of the redwood belt, on the higher slopes of the Coast Ranges and in the Sierras, is the region of mixed yellow pine and sugar pine. Farther north, in Oregon and Washington, are the great forests of Douglas fir, extending from the coast to the crest of the Cascades. More than a fourth of the valuable timber still standing in the United States is Douglas fir.

This measure is in timber, not in acres of forest. It represents the number of board feet of lumber that could be cut from the trees. The board foot is a lumberman's measure. It stands for a piece of wood one foot square and one inch thick. Lumber is measured in board feet no matter what is the actual size of the pieces. A board one inch thick, three inches wide, and four feet long would contain one board foot. So would a piece two inches thick, six inches wide, and one foot long. The measure really refers to the cubic content of the lumber. If you work out the problems and find the cubic content of the pieces mentioned above, you will see that all represent the same amount of wood. Trained foresters know how to work out the cubic content of the trunk of a living tree. By examining a forest area, they can tell about how many trees of one kind there are on an acre and the average size of the trees. That is how they are able to say that a fourth of the valuable timber in the United States is Douglas fir.

The western forests have other important trees. Fir, spruce, hemlock, and pine grow on the slopes of the Coast Ranges, the Cascades, and the Sierras. On the eastern slopes of the mountains, where there is less rain, the type of forest changes. Various pines become the most important trees. Ponderosa pine grows here and in many parts of the Rocky Mountains.

The map on page 124 shows small areas of forests dotted over the West. They seem to form a very curious pattern until you compare this map with the physical-political

United States on pages 378–379. The forest areas are mountain areas. So much of the West is high that you have to look closely to see where the actual ranges are. But you can find them even on the high plateaus by looking for the special mountain symbols. These symbols are rows of tiny lines that show where the land rises sharply. You learned earlier in your study of geography that mountains are rain catchers. Everywhere there is more rain on mountains than on surrounding lowlands. The higher mountains of the West have rain enough for trees, even though the surrounding land may be desert.

On the whole, the lumbering operations of the West are on a larger scale than those of the eastern half of the country. In the eastern forests there are usually many small sawmills close to the forests or even in the forests. In the West a few very large companies do much of the lumbering. By logging railroads, by truck, and on the rivers, logs come to huge sawmills. Along the coast some of the mills are in seaports and the sawed lumber can be loaded directly onto ships. From other mills the lumber must be carried by train to the seaports.

The forests of northern North America. Turn to the forest map on page 124. There you see that most of the forest regions do not belong to the United States alone, but extend northward into Canada. The New England and Great Lakes forests are not separate regions, but are joined across Canada. This whole area is really a transition belt between the central broadleaf forests and the vast coniferous forests to the north. In this in-between region the two types meet and mingle. Coniferous and broadleaf trees do not ordinarily grow together on the same piece of land. There are areas of one and areas of the other, too small to separate on a general map such as this. The commonest broadleaf trees in the region as a whole are birch and cottonwood, but there are areas that are true northward extensions of the central broadleaf region. There the broad-



K. S. Brown, Courtesy American Forest Products Industries

Towering Douglas firs dwarf three loggers in a valuable forest of the northwestern United States.

leaf trees are maple, oak, beech, hickory, and others. The broadleaf areas are larger in the southern part of the region; the coniferous, farther north.

Along the west coast, around the Great Lakes, and down the St. Lawrence Valley lumbermen work in the Canadian forests as they do in the forests of the United States. Lumber and pulpwood are exported. Many United States newspapers are printed on

paper made from Canadian pulp. Shiploads of Canadian paper go to Europe also.

North of the transition region lies the true northern forest, made up mainly of coniferous trees. There is not much lumbering or even cutting of pulpwood. The forest has valuable timber, and probably it will be used some day. At present, however, it is out of reach. The rivers flow north to the frozen Arctic Ocean. Railroads do not penetrate much of the region.

This is the forest in which the Indian trappers gather their harvest of furs. It was described in the chapter on hunting and fishing. As you go farther and farther north, the trees become shorter and shorter. The forest becomes the "land of little sticks," with small, stunted trees that are more like bushes than trees. Finally the tree line is reached and tundra takes the place of forest.

If you compare the climate of this region with the climate of the Pacific coastal region, where conifers are at their best, you will see why the trees are small. It is not only the cold, but also the dryness, that stunts their growth. They grow very slowly, too. That is mainly because of the shortness of the growing season. They cannot grow when the weather is below freezing, any more than other plants can grow then. They have, therefore, only two or three months for growing. It has been estimated that, if an area

of forest were cut at the southern edge of the coniferous-forest region, it would replace itself in about sixty years; but it would take an area at the northern edge of the belt about three hundred years to grow new trees to the same size.

The forests of Eurasia. The largest region of coniferous forest in the world extends across Eurasia from Scandinavia almost to Bering Sea. It is very similar to the northern forest region of North America, but much more lumbering is carried on. Sweden, Finland, and the part of the Soviet Union along the Baltic all export lumber and pulpwood in large quantities. Shiploads of wood pulp and paper go from the Baltic Sea region to the United States; but the best customers are people of European countries that do not have large forests of their own.

Sweden has a great advantage over most countries in lumbering. From the Baltic the land slopes upward into high mountains which are covered with fine coniferous forests. Lumbermen go into the forests in the winter to cut the trees. In spring the logs float down the rivers to sawmills near the mouths. Almost every river has a power plant and a sawmill that is run by hydroelectric power.

As you can see on the vegetation map, pages 370-371, by far the largest part of the great northern coniferous forest is in the Soviet Union. As in North America, the northern forest region is on the Arctic slope. Rivers flow northward into the Arctic Ocean. They are not so useful for transporting logs as they would be if they flowed toward warmer regions, but lumbering is carried on. Sawmills hum beside some of these cold rivers. Ships carry the lumber away on the Arctic Ocean.

Arkhangelsk, in the European part of the Soviet Union, is a lumber port. Farther east there

A Swedish lumberjack rides a log into the stream to get it started on its way to the sawmill. Lumbering is hard, dangerous work and requires great skill.

Courtesy Swedish Travel Information Bureau, Inc.





See foto

Rafts of logs towed on the Enisei River to Igarka, largest lumbering city of Arctic Siberia. The Enisei is one of the cold rivers that flow to the north. Igarka is north of the Arctic Circle.

are sawmills on the great rivers of Siberia. Lumbering in this far northern region of Siberia is a new industry. Modern inventions and a great need for lumber have brought the lumbermen and the sawmills to this region. Airplanes carry both people and supplies to the lumbering communities. Farming experts have found ways of growing a few crops in spite of the cold climate.

The only transportation route is the Arctic Ocean, which is frozen most of the year. Even in summer it is not open water. Ships must follow channels between fields of floating ice. Observers in airplanes find the open channels and report to the ships. Some of the ships are powerful icebreakers, specially built for crashing through ice that would stop an ordinary ship.

Along the southern edge of the forest lumbering is a much older industry. In the European part of the Soviet Union the southern part of the forest was cleared long ago. It is now a farming region. In Asia there has been lumbering ever since the long railway was built eastward to the Pacific. New lumbering regions were opened up wherever branch lines led into the forests.

The great northern forests are not the only forests of Asia. Have you ever heard of "elephants a-pilin' teak in the sludgy, squdgy

creek"? Kipling was talking about Burma when he wrote those words. Burma is in the monsoon region of southeastern Asia. There are heavy forests, but the trees must be able to live through the dry season in winter. Transportation difficulties are almost as great as in the tropical rain forest, and lumbering is carried on in a few places only. Teak is the most valuable tree. Elephants still pile teak in the forests and in the lumberyards, but most of this work is now being done by machines.

Not much is left of the broadleaf-forest belt of Eurasia. Western Europe was cleared for farming many hundreds of years ago, and now only a few small areas are left in broadleaf forests.

The mountains of central Europe have large forests of coniferous trees. The Alps, especially, are a valuable source of timber. Lower mountain and hilly regions are also used for growing trees. Most of these forests of Europe are very carefully managed. Trees are really grown as a crop. They are cut only when they have reached the best size, and young trees are planted in their places. Wardens patrol the forests to protect them from damage, to select the trees that are ready for cutting, and to make any plans necessary for improving the forests.

Forests of South America. In most respects you have found conditions in the Southern Hemisphere like those of the Northern Hemisphere. But this is not quite true of the forests. In the Northern Hemisphere the coniferous-forest belt begins at about 50° north. South America is the only continent that extends beyond the line of 50° south. The west coast of southern South America does have fine coniferous forests. There is a little lumbering, but the region has few people and is far from markets.

The vegetation map, pages 370-371, shows large areas of "grass with scattered trees" in South America. Some of these areas are open forests with many trees. The people who live in the regions cut the trees for lumber and firewood, but they carry on little commercial lumbering.

In spite of the difficulties of transportation, one kind of tree is cut in Paraguay and north-

ern Argentina. It is even exported. This tree is the quebracho. Quebracho wood is very hard and strong and especially desirable for railroad ties and many industrial uses. Most important, it is the best source of tannin in the world. Quebracho wood and extract are exported to the United States and Europe for use in tanning. The extract is prepared from the wood and is easier to ship than the wood itself.

The vast tropical rain forest of northern South America is thought to be the largest area of continuous forest in the world, but it is used very little for lumbering. As in the great coniferous-forest belt of the North, the difficulty is transportation. It does not pay, as yet, to try to build roads or railroads in this forest region. Building them and keeping them in repair would be very expensive. Another difficulty lies in the character of the forests themselves. Tropical forests are not made up of large stands of a few kinds of trees. There are many kinds of trees in these forests, and they are very different in hardness, weight, and color. Their wood must be handled and used in different ways. Often there is only one tree of a kind on an acre of land. Because of this scattered arrangement of trees, lumbermen must work over a large area to get a few logs of the more valuable varieties.

A few trees are cut for local use, of course, but the population is very sparse. For export, only a few varieties are cut, and the wood is marketed in small quantities. The trees cut are chiefly the varieties sold as cabinet woods. Because of grain, color, hardness, and ability to take a polish, they are especially good for making articles in which the beauty of the wood is important.

African forests. A little more lumbering is done in the tropical forests of Africa than in those of South America because they have a little less rain. The drainage is better, too, because the land is higher. Lumbering operations, though difficult, are not so difficult as in South America. A number of

Felling a mahogany tree in Africa. Mahogany is one of the most valuable tropical trees.

Courtesy British Information Services



railroads and roads penetrate the forest region. Only the more valuable kinds of timber are exported at present.

Wood around the world. Now you have seen most of the regions of large-scale lumbering; but trees are cut wherever they

grow. Wood is still the world's commonest fuel. In nonindustrial regions it is burned wherever there are trees. Even in industrialized areas many people burn wood. The world around, it is still the commonest building material, too. It is also a raw material in hundreds of industries.

CONSERVING THE FORESTS

On a day in the year 1608, Captain John Smith, president of the colony at Jamestown, sent out as many of the settlers as were able to prepare "pitch, tarre, and sope ashes." He took thirty others into the forest "to learn to make clapboard, cut downe trees, and ly in woods." Why did the little colony need thirty men to make clapboards, to fell trees, and to lay in supplies of wood? Why did the colonists need so much pitch, tar, and ashes to be used in making soap?

They were trying to get ready a shipload of forest products to send to England. Pitch and tar were secured from pine trees, as they are now. Fine wood ashes were a raw material used in making soap. English industries needed these products.

Almost three and a half centuries ago, when the first English colonists came to America, England was already running out of wood. The fine forests that once grew there had been cut down for lumber, for home firewood, for fuel and raw materials to be used in industries. The colonists in New England, as well as those in Virginia, had been asked to send forest products back to the home country.

As population and industries grew in western Europe, most of the forests were cut. People could not get along without wood. Something had to be done. Wood could be imported from less crowded regions, but not enough. People always seem to be able to solve problems when they try hard enough. Out of European need for wood came the beginnings of scientific forestry. As a result, well-managed, carefully cultivated forests

now grow in Europe. Even in some of the most crowded countries, the home forests meet nearly all the needs for wood.

Clear-cutting the Forests

While Europeans were learning to conserve their forest resources, lumbermen were going through American forests like a tornado. Their work was like a very slow-moving tornado, to be sure, but the results were just about the same. Where the lumbermen had passed, there was no more forest.

Endless forests. To the pioneers, the forests were an enemy to be destroyed. No more than a hundred years ago settlers were cutting down trees for no purpose but to clear the land. They had far more wood than they needed. The forest went on and on, except where men had laboriously cleared it away. Suppose someone had tried to tell those men that they should plant a tree every time they cut one down! Can't you just hear those pioneers laughing? They had plenty of ax callouses on their hands already and would have plenty more before enough land was cleared for a good farm. There would always be plenty of trees. The problem was how to get rid of them.

That was the American attitude toward trees a hundred years ago. It was a reasonable attitude for pioneers to have. Their job was carving farms out of the wilderness. When the trees were down and the stumps were pulled, the pioneers had fine, fertile farm land, where they could grow crops.

As you have read, no great commercial lumbering industry in America was ever based on broadleaf trees. The men who cut down the broadleaf forests were working to get the land, not lumber. Some of their sons and grandsons became commercial lumbermen. They worked in the lumber camps around the Great Lakes, in the South, and in the West. They carried with them the ideas of their pioneer fathers and grandfathers. Forests were something to be cut down and cleared away. There were plenty of trees—mile after mile after mile of unbroken forest. The lumbermen's method was to clear an area of trees and move on. Clear-cutting, they called it. They expected farmers to follow them onto the cleared lands.

And so the lumbermen cut the land clear. Big trees and medium-sized trees went down. They were dragged through the forest, crushing and breaking the little trees in their path. Tops and limbs were left strewn over the ground. When the tops, limbs, and broken trees were dry and crisp, then, more often than not, fire came. Fires set by a chance spark burned over millions of acres, destroying the dead wood, the little trees, the seeds, and sometimes even the soil.

These hardwood trees escaped the clear-cutting which leveled many broadleaf forests in the southern United States.

U. S. Forest Service, Courtesy American Forest Products Industries



In time a good many people began to worry about the forests. With a few exceptions, the people who began to worry were not the lumbermen. Cutting down trees was their business. When the good timber was gone from the Great Lakes region, there were still the great forests of the South. When the best timber was gone from the South, there were still the magnificent forests of the western mountains. Cut and move on. That still seemed a good program to the lumbermen. Only in recent years have they begun to realize that the forests are not endless; that, in fact, they have already come very nearly to the end.

Cutover lands. Other people had to face the problems of the cutover lands. At first no one knew there were problems. Settlers moved into the cutover forest lands and began to farm. But something was wrong. Crops did not grow well. Scientists know now that broadleaf-forest lands usually make good cropland; but coniferous forests grow on marginal forest land. They grow in the Far North where the growing season is too short for most broadleaf trees. They grow on mountain slopes where the weather is cool and the soil is thin. Conifers grow where there is not enough rain for most broadleaf trees and sometimes where there is too much. They grow on soil that is too sandy for broadleaf forests, on acid soil, and on soil that is low in fertility.

Even if coniferous and broadleaf forests started on equally good land, the soils would not be equally good for crops when the two forest areas were cleared. When the leaves and dead branches of broadleaf trees fall and decay, they improve the soil for crop plants. The decayed needles and wood of coniferous trees add materials that are not good for crops.

Where the coniferous forests were clear-cut, there are now millions of acres of wastelands. Where the land was cleared long ago, second-growth forests now cover part of the area. Some of the second-growth timber is large enough to be useful again, for pulpwood if not for lumber; but the varieties of trees are often not so good as the ones that grew there originally. For example, in the Great Lakes region the most valuable tree was white pine. There is scarcely any white pine in second-growth forests. The pines were so completely cleared away that few trees were left for seed.

The United States government calls the cutover lands "problem areas." They are problem areas because they are lands of poor resources. The climate and soil are good for growing coniferous trees, but they are poor for growing anything else. Since there are few resources, people have few choices of occupation. Most of them must somehow make a living from what is left of the forest. Many of the people live in log cabins surrounded by woods. There are a few stands of trees large enough to be cut for lumber. Truckloads of logs pull out of the woods and head for the sawmills. Most of the sawmills are small, and so are most of the logs. There are also pulp and paper mills, which can use timber too small for the sawmills. Railroad ties can be sawed from trees that are not very large. Small trees are cut for use as props to keep mine tunnels from caving in, for piling, and for firewood. Every Christmas season thousands of young trees are cut for Christmas trees.

In these wild and sparsely populated regions, deer and other game animals are plentiful. The lakes and streams are well stocked with fish. Many of the inhabitants make at least part of their living by hunting and fishing. Vacationists come for hunting, fishing, and other sports. They need guides and people to provide them with food and places to stay.

Perhaps all this sounds as if there were a good many things to do in the cutover areas.

All the occupations depend upon the forests, however. They all use the few leftovers of once great forest resources. They do not support many people and they do not support even a few people well. A half-day's drive through one of these cutover regions would show you very clearly that most of its resources are extremely poor.

Values of the living forest. Useless land was not the only problem left by lumbermen, especially when they cleared the trees from steep slopes. When rain falls on a forest area, it drips slowly from the leaves to the ground. There it sinks into a deep layer of leaves and humus, or partly decayed leaves, branches, roots, and trunks of trees. The leaves and humus behave very much like a sponge. They soak up the water and hold it. Very slowly the water trickles through this spongy layer to the streams and flows away. Streams in a forest region have water in them even in dry summer weather; but they seldom overflow, even after heavy rains.

Rain that falls on bare ground or cultivated fields runs off at once. Comparatively little of it soaks into the earth. The loss of water is bad enough, but that is only the beginning of the damage. Erosion is more serious. As the water runs away, it carries the soil with it.

Floods usually come in spring, during the season when most of the country has its heaviest rains. Every little stream rises and pours an extra load of water into the larger rivers. These larger rivers rise higher and higher as they collect the waters of more and more tributaries. Soon they overflow their banks and, if they rise high enough, destroy much property and sometimes many lives.

If you look at the map on pages 382-383 and follow the great river systems upstream, you will find most of the rivers and their large tributaries rising in mountainous regions. Forests on higher mountain slopes help to prevent floods. When the upper slopes are forested, the water that falls on them trickles slowly into the streams. The

water makes its way gradually into the rivers below and is carried away without causing a flood.

Forests on mountain slopes regulate the flow of water into the rivers of the lowlands. They not only prevent floods but also provide an even flow that makes the rivers more useful. When the rivers are used for irrigation, they are much more valuable if they have about the same quantity of water at all times of the year. The same is true of their value for water power.

New Forests for Old

People are not always very farsighted or very wise. They are a long time finding out that a problem exists. Then they are a longer time finding the right answers.

Save the trees! Early in the twentieth century a few people began to notice that the forests were disappearing. They talked about *conservation*, and by that they meant saving the trees so that future generations would still have trees to use.

Isn't it funny that when people first discover something wrong they almost always

A Forest Service "smokechaser" is ready to fight a fire. The smoke was spotted by a fire watcher from his lookout tower, rising high above the forest.

Courtesy U. S. Forest Service



begin scolding someone? Those first conservationists scolded the lumbermen for cutting trees. They wrote articles scolding their own ancestors for cutting down the broadleaf forests, as if it were wrong for pioneers to clear land for farms. They scolded all their fellow citizens for not seeing the problem as soon as they themselves did.

Scolding never solves a problem, but perhaps it did a little good. The United States government set up the Bureau of Forestry, now called the United States Forest Service. Canada has a similar organization called the Dominion Forest Service. The purpose of the Forest Service was at first just to save the trees—to keep as much as possible of the forest untouched for the future. The forests were not all gone. Conservationists did not say they were. They only said that at the rate the trees were being cut, the forests would be gone in a very few years.

Large areas of uncut forests belonged to the government. Many of these areas were in the mountains and other hard-to-reach places. Great stretches of cutover land had gone back to the government because the lumber companies had no further use for them. When the trees were cut, the lumber companies packed up their camps and moved on. They stopped paying taxes, and, as a result, the government took over the land. Additional areas were bought to be added to the national forests.

One important step in saving the forests is fire protection. Fire is a greater enemy of the forest than even the clear-cutting lumberman. There have been fires that burned more than a million acres of forest. Every year timber worth thirty to forty-five million dollars burns up in the United States alone. Even the most reckless clear-cutting lumbermen leave a few small trees alive and seeds in the earth. A fire leaves nothing but dead, blackened stumps. It may even burn the humus out of the soil.

The Forest Service has a whole army of fire fighters. Men in high towers watch for smoke during the dry parts of the year.



U. S. Forest Service, Courtesy American Forest Products Industries



Lohr, Courtesy American Forest Products Industries

Young trees often are grown from seed in nurseries. Under careful supervision, they get a good start. Then foresters help to conserve some of the dwindling forest areas by setting out new trees.

When a lookout in his tower sees smoke, he calls the nearest forest-ranger station and reports. He gives the exact direction of the smoke from his tower. If two watchers report the direction from their towers, the fire can be located exactly. Well-trained and well-equipped fire fighters rush to the fire.

Most fires are put out before they can do much damage, but it would be better to have no fires at all. A few fires are started by lightning. A larger percentage are started by careless people. One important task of the Forest Service is to teach people to be careful not to start fires. That should not be necessary, but unfortunately it is.

There are other dangers to the forests. Forest rangers fight insects that damage the trees. They try to keep tree diseases from getting a start. They watch for damage by animals. An important part of the job has always been protecting young trees. If, for example, there are too many deer in an area, they will eat the young trees. Then hunters may be allowed to come in and shoot some of the deer. Or some of the deer may be caught and moved to another area.

You read on page 101 that sheepherders are allowed to pasture their animals on government land for a fee. Cattlemen use the land, too. The forest rangers must decide which areas are suitable for sheep and which for cattle. They direct the herders and watch to see that the rules are obeyed.

The Forest Service also plants trees on cut-over or burned lands. Sometimes the foresters plant seeds, but squirrels and other animals eat many of the seeds. A good many fail to grow under forest conditions. Forest trees scatter millions of seeds for every seed that becomes a tree.

The foresters have better success when they grow young trees from seed in nurseries. The little trees come up tightly packed together and are given as much care as crop plants. Then, when they have a good start, the foresters set them out in the forest, or where they want a new forest to grow.

Forests may be used. The Forest Service studied trees and forests. The foresters studied forestry techniques used in Europe and worked out new ones to suit American



Rogon, Courtesy American Forest Products Industries

With a paint gun this forester is marking for harvest the mature trees in a western pine forest. The unmarked trees will be left to mature and to provide seed for a new crop.

forests and American problems. They found that it is not necessary to save areas of unused forests for the future.

Has anyone ever quoted this old proverb to you, "You can't eat your cake and have it, too"? The foresters discovered that, as far as forests are concerned, you can eat your cake and still have it. In fact, you can even have a better cake. The Forest Service is now practicing forest management for sustained yield, which means a continuous yield of timber. This is the way it is done.

Trees are cut down, but the forest is never cleared. Lumber companies get from the Forest Service the right to cut timber in a national forest. They pay according to the number of board feet that can be cut. Several methods of logging are permitted, according to the kind of forest. When there is a stand of trees all about the same size, clear-cutting may sometimes be permitted, provided some seed trees are left. Seeds of

coniferous trees are carried by the wind. If a few trees are left on each acre, their seeds will reach all the land and start a new forest. The length of time it will take for the trees to be ready to harvest again depends upon the rainfall, the length of growing season, and the variety of tree.

More often a forest has trees of all ages and of several kinds. In such a forest an experienced ranger marks the trees that may be cut. First he marks the less desirable kinds of trees. Their wood is useful, but less useful than some other varieties of wood. They are all marked for cutting. Then the ranger marks trees that he calls cripples. These are trees that have been broken by the wind, split by lightning, or damaged by insects or disease. They are not very valuable but have some use, and the forest is better off without them.

Most important for lumber are the mature trees that will grow very little more. They are fine trees, but they will never become any larger or more valuable. They take up water and soil fertility that growing trees could use. They shade the young trees beneath them. They are the trees most likely to be damaged. The forest as a whole is better off without these trees, too.

Cutting and transporting selected trees is a little more trouble than clear-cutting, but it is the way lumbering has been carried on in Europe for a long time. In the long run it pays lumber companies to plan for sustained yield. They are better off than they would be under the "cut-and-move-on" plan. Besides, they had almost reached the end of their timber resources. Before long they could not have moved on.

Many companies are using the sustained-yield plan on their own timberlands now. They take the mature trees from one area this

year. Next year they will take the mature trees from another area. In a few years they will have covered all their land. But by that time the largest of the young trees on the first area will be ready to cut. This can go on for centuries. A hundred years from now the forest will be just as good and just as productive as it is today. In fact, it will be more productive, for it will have only the best kinds of trees, properly spaced, and protected from harm.

Americans have always liked to think of themselves as living in a rich and fertile land. They have not liked to admit that whole

regions may be good for nothing but growing trees. Nearly all of them know and admit it now. When the work of forestry has been carried a little farther, there will be no cut-over regions. Population will not be dense in the forests. Forest industries do not support a dense population; but the regions of poor resources will be as useful as it is possible for them to be. The forests are large enough to supply all the wood the country needs if they are properly used. A third of the land in the United States is now forested, and it is probable that nearly all the land of that area should remain in forests.

FOREST PRODUCTS

So far you have been reading mainly about forests as producers of wood. Only lumber, paper, and fuel have been mentioned. If you have been watching for uses of wood in your community, you do not need to be told how wood is used as a raw material in building and manufacturing. You know about a good many other forest products if you stop to think.

Naval stores—tar, pitch, and turpentine—are forest products. So is wild rubber. On

pages 109–112 you read that many wild forest trees have been domesticated and are now grown on plantations in tropical regions of the world. The same kinds of trees still grow wild in the forests, too.

Gums and waxes. The people in the pictures are gathering a product of the dry forests at the edge of the Sahara. They are not picking fruit. The rounded objects are gum arabic. The gum oozes out of cuts in

Amber “tears” of gum arabic ooze from cuts made in the bark of small trees. In the pictures the tears are being gathered from a tree in a gum garden in the Anglo-Egyptian Sudan. The picture at the right shows the animal-skin containers into which the Sudanese harvesters put the tears.

British Information Services

British Information Services



the bark of small trees. It is used in mucilage. Gum tragacanth is gathered from small trees in southwestern Asia. If you read the labels on bottles of meat sauces, you will find one use for it.

Chicle is a gum collected from the sapdilla tree of tropical America. It is the principal raw material in chewing gum. Many gums are used in paints and varnishes—gums called copals, from forest trees of several kinds growing in New Zealand, Malaya, Zanzibar, and Madagascar; lacquer, from the sap of the lacquer tree, which grows in eastern Asia. The most widely used wax is carnauba wax, scraped from the large leaves of a Brazilian palm. You have probably used it often, for it is one of the raw materials in many kinds of shoe polish. It also goes into furniture and automobile polish, photographic film, and phonograph records.

Forest fruits and seeds. Brazil nuts are the seeds of a tree of the Amazon Valley. None of the trees are grown on plantations. The nuts are all gathered from forest trees. Kapok is a fiber from the seed pod of a South American tree, now sometimes grown on plantations. It is used for stuffing upholstery and life preservers. Another forest tree of the Amazon Valley has nuts so hard that they are called vegetable ivory. Buttons are cut out of the hard meat of the nut.

Palm oil and coconut oil are only two of many vegetable oils made from the fruit and seeds of trees. Many of these trees are grown on plantations, but fruits and nuts are collected from the forest trees, too.

Products from wood and bark. You know about the use of quebracho wood in tanning. Many other kinds of wood and bark are used for the same purpose. Sweet-scented oil from sandalwood is used in many perfumes. Camphor comes from a tree that grows in eastern Asia—especially on the island of Formosa. Dyes are extracted from the wood of various trees. Cork is the bark of an oak that grows in Spain and Portugal and in the Atlas Mountains in Africa.

Tamed forests. All trees were once wild, just as other plants were. People tamed some of the useful ones a very long time ago. Our common fruit trees were domesticated so long ago that scientists cannot be sure about their native homes. The Greeks believed that the goddess Athene had taught people how to grow olives for oil. Sugar-maple trees were half-domesticated by the colonists in America, who kept the natural groves of sugar maple trees when they cleared their farms. Other trees have been domesticated very recently. You read about them in the section on plantation agriculture.

Now the forests themselves are being tamed, although there are still vast untamed forests in the world. The great coniferous forests of the Far North and the tropical forests are not even fully explored.

Even the carefully managed forests still look like forests, not like plantations. But forest trees are grown in nurseries, the forests are watched and protected, and wood is harvested as a crop. Forests managed in this way can scarcely be called wild.

A WORKSHOP ON FORESTS AND FORESTRY

It is fun to be able to recognize different kinds of trees. Be sure to learn at least the trees of your own neighborhood. A good woodsman knows a tree by its leaves, flowers, fruit, bark, or general shape.

You should also learn to recognize a few kinds of wood. Find out what kinds of wood

were used in the woodwork of your home and in the furniture. If possible, get samples of a number of kinds of wood.

How do the different kinds differ in appearance? What will you try to remember about each kind, so that you will recognize it the next time you see it?

Your Community as a Laboratory

What you do in your community study depends upon where you live. You may live in a lumbering community, in which most of the people work with forest products. On the other hand, you may live on the open plains without a tree in sight between you and the horizon. From the following suggestions, choose the ones that fit the resources and occupations of your own community.

WOOD PRODUCTS

At the beginning of this chapter, it was suggested that you make a list of uses of wood, and that you make another list when you finish the chapter. How many more items were you able to put in the second list than in the first?

Every community has carpenters among its workers. Talk to a carpenter about the kinds of lumber he likes to use for different purposes. Ask him to tell you why he likes some kinds better than others.

Has your community any factories using wood as a raw material? If so, find out what kind of timber they use for their products and where they get it.

Do the forest trees of your region provide any useful products besides lumber? Are the forests used for recreation? List as many uses of the trees and forests as you can.

IN FOREST REGIONS

If you live in a lumbering community, you will probably want to spend quite a little time studying the local industry. Your study will include kinds of timber, lumbering methods, preparation of the lumber for sale, transportation, and markets. Do you think good conservation practices are being carried out? What improvements in these practices would you suggest?

Perhaps your region is not forested now, but was forested at some time in the past. If this is the case your study will be historical. When, how, and why was the land cleared? Should it have been kept in forest? What was gained by clearing it? What was lost? Do you think any of this land should be reforested now?

Find out what kind of trees were the original forest trees of your region. Look for examples of them growing in fields or as

shade trees. If you were planning to reforest an area, which of these trees would you choose?

FORESTRY AT HOME

If you live on a farm, and if the farm has a wood lot, make a careful study of the timber. If you have an opportunity to carry out this project and would enjoy it, you might very well use all your workshop time for it. Perhaps you would like to ask some of your classmates to help you. At the end of the study, prepare a report for the class.

Here are some of the things you might do.

1. Make a map of the farm, showing the wood lot.
2. List the varieties of trees and estimate the number of each.
3. Find out whether there are young trees growing well. If so, do they represent all varieties? If there are few young trees, try to find out why there are so few. What can you do about it?
4. Are the trees the best varieties for your region? If you think other varieties should be added, could you get seeds or young trees and plant them?
5. With chalk or paint, mark the trees that you think should be cut first.
6. Make plans for the use of the wood lot so that you will be able to get the highest possible sustained yield. Consider whether you want firewood, logs for lumber, posts, or any other products.

Test Your Skill and Knowledge

Try the following activities at the end of your study of forestry. They will test your understanding of what you have read.

If you live in a city, you might make a plan for a small park, perhaps a block square. It should include as many as possible of the native trees and shrubs of your own region. Plan to plant trees with attractive flowers and trees that will provide feed for birds, if such trees grow naturally in your region.

Plan to plant one tree in your own yard if you can. Perhaps you would enjoy growing a tree from seed. Of course you will have to wait for the right time of year. That will give you time to make a careful selection of the best kind.

CONIFEROUS OR BROADLEAF?

Each of the drawings below is a picture of a tree or something that grows on a tree. Which represent coniferous trees and which broadleaf trees?



WHAT IS FOREST CONSERVATION?

Imagine you work for a lumber company that has just bought a large tract of land in mountain country. You are to be in charge of the lumbering operations. The owners tell you that they naturally want to make as large a profit as they can from the timber, but that they believe in conservation. They expect you to make your plans so that the company will get a sustained yield of lumber from the forest.

You study the forest carefully. From your study you learn that it is a mixture of several varieties of trees, some much more valuable than others. There are trees of all ages, from old, crippled giants to tiny seedlings.

Each group of questions below indicates a choice you will have to make as you plan your operations. Keeping in mind the instructions of the owners, which answers will you choose?

1. Will you begin the lumbering operations in your large tract of land by
 - a. marking off the land in sections to be cleared one by one?
 - b. going through the whole forest, marking the individual trees to be cut?
2. Will you
 - a. mark all the trees of the poorer varieties for cutting?
 - b. mark only trees of the better varieties, hoping that you can get a higher price for poor lumber when good lumber becomes scarce?
3. Will you
 - a. mark for cutting all the strong, healthy

trees down to the smallest marketable size?

- b. mark all the crooked, broken, and hollow trees and the trees that have reached their full growth, leaving even the large trees that are still growing?
4. One area of several square miles has nothing but large trees that have completed their growth. Will you
 - a. mark all of the trees in the area for cutting?
 - b. leave three or four standing on each acre of land?
 5. Another area of several square miles was burned over last year. All the trees were killed. Will you
 - a. buy young trees from a nursery and plant them?
 - b. wait until the area has been reseeded naturally?

A QUIZ

What word should replace the xxxxx in each of the following sentences?

1. In the middle latitudes, most broadleaf trees shed their leaves in the fall; most coniferous trees keep theirs and so are called everxxxxx.
2. The leaves of broadleaf trees are simply called leaves; the leaves of most coniferous trees are also called xxxxx.
3. A walnut is to a walnut tree as a xxxxx is to a pine tree.
4. Softwood is to hardwood as coniferous is to xxxxx.
5. Lumbermen cut down trees for lumber; gatherers of resin, rubber, gum arabic, and chicle xxxxx through the bark of the trees in order to get useful products from them.

ADDITIONAL INFORMATION

When you have found out the names of forest trees that grow in your region, you may want to learn more about them. An encyclopedia will give you many details that you can use. Even a dictionary will give you a little information.

The United States Forest Service and the Dominion Forest Service, in Canada, have interesting pamphlets on North American forests and forest conservation. If you write for any, be sure to say you want them for use in school.



Miners and Other Mineral Workers

WE USE EARTH MATERIALS

Did you ever crack a nut or drive a nail with a piece of the earth? You probably called it a stone. Stones are rock, and the solid earth is made of rock—even the tiny bits of soil are broken rock. True, there are things in the earth besides rock. Part of the soil is humus, made up of decayed plant materials. Earthworms burrow in the ground. Water fills the spaces between soil particles. None of these substances are rock; but they are only a small part of this vast ball we know as the earth.

Is there a stone building in your community? It is made of part of the earth cut up into blocks. The rock is not changed in any way except in shape. Brick buildings, too, are made from earth materials. Bricks are made of softer earth materials, pressed into shape and baked. The earth materials are changed a little by the heat, but if you

crush a piece of brick, you can see that it still looks like earth.

Other materials do not look at all as they did in the earth. Maybe you never cracked a nut or drove a nail with a stone; but if you used a hammer instead, you were still using part of the earth. The hammer head was made of steel, which was made from iron. Iron comes from the earth, but in the earth it does not look in the least like the head of your hammer. The most commonly used iron ore is a rusty-red rock. The ore is a *chemical compound*. There is iron in it, but it does not look or act at all like iron. Many earth materials are like iron ore. They are of no use to us until the compounds have been broken down by chemical processes.

You have seen how farmers and forest workers get materials from the earth by way of plants. Now you are going to meet the

workers who bring us parts of this rocky earth itself. They blast out great pieces of it, scrape up millions of tons of its surface, drill deep wells in it. The map at the top of page 143 shows where most of them work.

If any earth materials are secured near your community, try to get samples of these

materials just as they come from the earth. Then find out what must be done to them to prepare them for use.

Before you go on, turn to the Workshop beginning on page 179. There you will find more suggestions to guide your study of earth materials and people who work with them.

STONE, CLAY, AND SAND

Perhaps the very first people who lived in the world used earth materials just as they found them, as you might use a stone to crack a nut. Then, a very long while ago, someone made the world's first invention. He discovered that he could make a stone more useful by breaking it. In nature most stones are rounded. A stone that is broken has sharp points and sharp edges. It can be used to pierce and cut and scrape.

The Ages of Stone

From that first broken stone to our modern use of earth materials is a long, long way. There is not room in this book to tell you the whole story. The whole story is the whole history of civilization.

Old Stone Age tools. In time, the early people learned to make real tools of stone. The oldest tools that scientists have found are heavy and clumsy. They were not specialized. People probably used them for chopping and cutting and as weapons.

The people who made these oldest tools had already discovered that some materials are more useful than others. Most of their tools were made of a kind of rock called flint. Flint has a quality that makes it especially easy to shape. When it is struck sharply, a flake breaks off. The flake is not flat, but rounded. When a series of oval flakes are chipped off the margin of the rock, a sharp edge is left.

The first crude tools were not very sharp, because the flakes were large and irregular.

People learned to make better ones. They also learned to make different tools for special purposes. They made good axes, knives, scrapers, sharp points for boring holes, and even saws. Scientists of our own time have used these tools, and they say that good work can be done with them.

New techniques. Now we come to the people of the New Stone Age, who knew how to use a great many more materials from the earth. Scientists usually date the New Stone Age from the invention of farming, but many other inventions were made at about the same time. One of these inventions was a new technique used in working stone.

At about the time of the first farmers, techniques of grinding and polishing were invented. A workman ground away one stone with another until he had hollowed out a bowl or shaped an ax. The grinding technique gave workmen much more control of their material. They could make a stone any shape by putting enough time and work into the job. They also had a wider choice of raw materials, for they could choose any kind of rock that seemed suitable.

Besides farming and the new stoneworking techniques, a third great invention marks the beginning of the New Stone Age. This was the making of pottery from clay. We do not know just where the invention was made, but it seems to have been somewhere in the region where farming began.

People of the New Stone Age discovered another use for clay. They learned to shape it into bricks. The first bricks were large and

thin and were dried in the sun. A little later, brickmakers learned to make bricks about the shape of our own and invented the process of hardening them by baking.

It may surprise you to know that glass is also a very old invention. Glass is made by melting sand. Perhaps on the desert sands of Egypt someone built a fire so hot that some of the sand was melted. More likely it happened often before a great inventor of his day saw how the melted sand might be used. However it happened, our museums have many glass bottles from ancient Egypt. The makers colored some of these bottles by mixing pigments with the melted glass.

Like other techniques you have seen, the making of pottery, bricks, and glass spread over the earth. Although now most of the work of making them is mechanized, our present techniques are only improvements on very old processes. The *basic inventions* were made thousands of years ago.

A basic invention is one that uses an entirely new idea and makes possible a new use of materials or opens the way to new techniques and other inventions. For example, in glassmaking the basic invention was made long ago by the inventor who discovered that sand could be melted and that the melted material could be shaped into useful articles. Since that time thousands of other inventions have been made in the glass industry, but the basic invention was the original one of melting sand to make glass.

Solid Rock

We still use a few earth materials almost as simply and directly as people used them thousands of years ago. For example, the city of El Paso, Texas, has a number of houses built of beautiful pink stone. You can stand in the street looking at a pink stone house, then lift your eyes and look at the slopes of a pink mountain rising at the edge of the city. The builders simply brought down blocks cut from the mountain and used them to build the house.

The rocks we use for building. You probably know that different kinds of stone have names. The kinds generally used as building stones are limestone, sandstone, marble, granite, and slate. There is no way to learn to recognize them except by seeing and handling them for yourself. If there is a stonecutter in your community, he can probably give you chips as samples.

Limestone and sandstone are the stones most commonly used for the outside walls of buildings. Marble is more frequently used on the inside. Walls may be built of granite, but granite is more often cut and polished for pillars and monuments. Slate can be split into very thin sheets. The sheets are cut up and used to cover roofs.

The removal of any useful material from the earth may properly be called mining, but we do not ordinarily speak of a stone mine. Stone quarry is the usual term.

The techniques of quarrying are quite simple. If the rock is covered with soil, this is removed first, usually with scrapers. Loose and broken rock must be removed, too. Then the quarrymen take out slabs of rock, working downward in terraces. The old method was to bore a row of holes in the rock and force in wedges until the rock split along the line of holes. This is still done sometimes. If explosives are used in the holes, the charges must be very light. Heavy explosions would shatter the rock.

Hoisting machinery lifts the rock out of the quarry. Somewhere near there is usually a shop where the stone that has been quarried is trimmed and cut into blocks or other shapes that are needed for building.

Stone is heavy, and transportation is always a problem. Usually railroad tracks or truck roads run to the edge of the quarry. Machines move the blocks and hoist them onto the cars or trucks. But the moving of such heavy material as stone is still costly. Most building stone is not carried far.

There are exceptions. Fine marble is sent long distances. An especially beautiful marble from northern Italy is even imported

into the United States. Georgia, Vermont, and Tennessee produce most of the marble quarried in the United States. Marble is generally used in small quantities for decoration. Builders who want it are willing to pay for the costly transportation.

More than three-fourths of the limestone used for building in the United States comes from quarries of attractive, easily worked stone in southern Indiana. This Bedford limestone is shipped all over the country, but it is seldom used except for fine buildings that are expected to be costly. University buildings, government buildings, churches, and museums are the kinds most likely to be built of Bedford limestone. Few ordinary buildings are made of any kind of stone unless the stone can be quarried near by.

Stone has been used for building since ancient times and among all peoples who have made even a beginning in civilization. The ancient Egyptians did fine work in stone. The Mayas of Mexico and Central America and the Incas of the Andes region did equally good work. Ruins of ancient stone buildings stand on the plateaus of Iran, in the jungles of southeastern Asia, among the dry forests of southern Africa, in the desert of Arabia. Few of our uses of earth materials have changed so little since prehistoric times.

Crushed and broken stone. In modern times, cut stone for buildings represents only a small part of the stone that is quarried. Limestone ground fine is the principal raw material used in making cement. Then the cement is mixed with crushed stone or gravel in preparing concrete. Limestone is also a necessary material in iron smelting. Farmers buy great quantities of limestone for use as fertilizer. Some use ground limestone, and others prefer lime, which is the product obtained by burning limestone. Railways are laid on beds of crushed stone, called ballast. Crushed stone goes under the surface of paved streets and highways. Finely crushed stone is mixed with other substances to make roofing materials. Large pieces are

spread along shore lines to keep the water from washing away the land and are piled offshore to form breakwaters.

Rock Crushed by Natural Forces

The forces of nature are very efficient stone crushers. For countless years frost and sun have been cracking the rocks of the earth. Flowing water has tumbled the broken pieces, rounding off their corners, wearing them smaller. The tumbling stones have slowly plowed the stream beds deeper into the rock. Great ice sheets have ground across the land, scraping the rock beneath them. Even the wind has had a share by blowing sand against rock.

Gravel. Gravel is one of the useful products of nature's stone crushers. It is just a mass of small stones with round corners. They may be any size from tiny pebbles to fairly large pieces. Gravel is used like machine-crushed stone in concrete, in making roads, and for railway ballast.

Gravel deposits are usually the result of the action of water. Stones roll along in the water of swift streams. Then the stream slows down and the stones are dropped. Or perhaps stones are tumbled by waves along the shore of an ocean or lake and are finally rolled up on a beach.

The place where gravel is dug is called a gravel pit. Gravel pits are operated where the gravel is on or near the surface. Not many men are needed to work them, for they are highly mechanized. Usually a gravel pit is simply a large hole in the ground, with machinery set up at one side. The gravel is scraped up with power shovels or with a machine called a dragline. The picture on the next page shows how a dragline looks.

Sometimes gravel is dredged from stream beds. A dredge floats on the water. In the most usual type, a series of scooplike buckets are attached to a conveyor that goes down through the water to the stream bed. The

buckets on the conveyor scoop up the gravel and dump it on the deck of the dredge.

Sand. Like gravel, sand is scooped up from the surface of the earth. For some purposes, almost any sand will do; for others, there are specific requirements. Glassmaking, for example, usually calls for white sand. The chemical composition also must be right. For some uses, the grains of sand must be rounded. For others, sharp-cornered grains are better.

Sand, as well as gravel, is used in concrete and mortar. Many pavements are laid down on a bed of sand, which rests on gravel. Vast quantities of sand are used for molds in foundries where metal castings are made. Sand is sprinkled on railroad tracks to keep locomotive wheels from slipping. Sand filters purify water for drinking and industrial uses. Stone and brick buildings are cleaned with a machine that blows sand against them to scour away the dirt.

Clay. Clay also is made up of very fine rock particles—much finer than sand. There are different kinds of clay, with different chemical compounds in them. The useful qualities of clay were discovered more than five thousand years ago. Techniques in using it have changed and improved. It is true that more things are manufactured now from clay, but the basic inventions were made before the beginning of history.

Pottery making was not an industry in those days. It was housework, like sweeping and dusting and preparing a roast for dinner. Clay is very common, but some clays are better than others. There was a usable claybank near almost every New Stone Age village. When a woman needed a new jar or bowl, she made it herself. She dug up the clay, shaped it, and baked it.



Courtesy Link-Belt Speeder Corporation

Gravel from one of the earth's many and widely scattered gravel pits is dumped into a truck by a bucket on a dragline cable.

We do not know just when a few extra-skillful pottery makers began to specialize in the work, trading pottery to their neighbors for food and clothing. We do not know just when men took over the job of pottery making from the women. Probably it was about the time pottery making became a job instead of a part of housework.

Ancient potters did all the work themselves, from digging the clay to selling the dishes. Much later there was a little specialization. Some men worked all the time in the clay pits. Artists specialized in putting on the designs. In other words, there began to be *division of labor*.

That is an important term to learn. It means the dividing up of work so that each person does only part of any piece of work. In very early times there was no division of labor, except within the family. Later a few workers began to specialize. The Bible mentions, among others, potters, carpenters, blacksmiths, shepherds, stoneworkers, merchants, and hewers of timber.

Pottery making today is a good example of division of labor. Techniques vary in different places, but this is what you might see in an ordinary clay pit. Railroad tracks run into the pit. A crew of men moves the

tracks as they are needed, or adds new sections. Men of this crew do nothing else. The men of another crew do nothing but loosen the clay. Others run scrapers that push the clay into heaps for the power shovels to pick up. Still others operate the power shovels that pick up the clay and load it on little cars. The cars may be fastened to cables and pulled out of the pit by an engine at one side. One man runs the engine. Another does nothing but hook the cars to the cable. Then comes the pottery works, where the dishes are made. In making pottery there are almost a hundred different jobs. The number of people working at each job depends upon the size of the establishment.

Clay is a very common substance. There are few regions in the world that do not have it. It is not all the same, though. Some kinds are better for one purpose, some for another. Some clay is not really very good for any purpose.

A few clay deposits are world-famous. Millions of Americans eat from English dishes because of a deposit of very fine white clay in southwestern England. Most Americans who use imported English dishes buy them because they like the designs or because they have heard that English dishes do not break easily. The English potters do fine work. Some of their techniques do make the dishes more durable; but without the exceptionally good clay the work and the techniques would not produce such good dishes.

The fine white English clay is a variety called kaolin. There are other deposits of kaolin in the world. Some in France, eastern Germany, and China are also world-famous, or, rather, the dishes made from the kaolin are world-famous. North America has only a few deposits of good quality. A large part of the kaolin produced in the United States comes from Georgia.

Bricks are a clay product nearly as old as pottery. An establishment for making brick is called a brickyard. In almost every region of the earth there are brickyards and clay pits to supply them with clay.

Besides pottery and brick, many other products are made of clay. Most of them are grouped under the name of tile. There are the hollow tiles used for draining land and for sewer pipes; there are roofing tiles; and there are any number of kinds of colored and decorated tiles for walls and floors.

Rocks with Unusual Qualities and Uses

Building stone, gravel, sand, and clay are used in larger quantities than other rock materials, but they are not by any means the only ones used. Many rocks are used because they have unusual qualities of some kind. The following examples are only a few out of the many that might have been chosen. There is not enough room in this one book to tell you about all of them.

Precious stones. Of course you have heard of precious stones. Emeralds are the most valuable of all, but diamonds are the best known. Diamonds have always been highly valued. In early times most of them came from India, where they were found as pebbles in the gravel along streams. Later, diamonds were found along streams in Brazil.

Then came the greatest find of all, in South Africa, a little after the middle of the nineteenth century. In South Africa, too, diamonds were at first picked up from the gravel along the streams. Later, however, they were traced to masses of rock that had once been melted lava. The running water had washed out the diamonds and had left them in the gravel, just as if they had been ordinary stones.

Some of the diamond mines are deep, open pits. Others are deep shafts with tunnels leading off from them. Someone has said that the diamonds in the rock are like raisins in a pudding. Miners dig out the rock. After the rock has been mined, it is crushed, washed, and sifted to sort out the diamonds.

Gem diamonds are beautiful and glamorous, but other diamonds, not beautiful at all,

are more important to the world. These are called industrial diamonds. Industrial diamonds may be imperfect gem diamonds; also, pieces trimmed off in cutting diamonds are used in industry. Diamonds are valued in industry because of their hardness. Gem diamonds are hard enough to cut glass. Black diamonds, which are found in Australia and in Brazil, are even harder.

You may never have seen industrial diamonds, but you have seen something that could not have been made without them. The filaments in electric-light bulbs are made of tungsten, a very hard metal. Fine wire for the filaments is made by drawing tungsten through an opening in a diamond. Nothing but diamonds is hard enough to draw this hard metal out into a fine wire.

Rock fibers. The emperor Charlemagne lived more than 1100 years ago. Charlemagne had a magic tablecloth. At least, it seemed like magic to his guests. After dinner, Charlemagne astonished his guests by picking up the tablecloth and throwing it on the open fire. It did not burn. It came out of the fire beautifully clean.

Charlemagne's tablecloth was made of rock—a very unusual kind of rock called asbestos. In his time asbestos cloth was a curiosity. Cloth that would not burn was astonishing and rare. If someone had a piece, he might use it to play jokes on his friends, but it had no real value.

Asbestos has many uses now. You can see some, if you like, perhaps at home and certainly in stores that sell household equipment. Asbestos is made into mats to place under hot dishes on the table. It is often used between the double walls of an oven, but you cannot see it there.

Resistance to heat and fire is the quality that makes asbestos valuable. Fireproof curtains in theaters are made of asbestos. Asbestos clothing protects firemen who must fight dangerous blazes. As cloth or paper, it is wrapped around furnace pipes. As asbestos cement, it is put into fireproof



Courtesy Johns-Manville Sales Corporation

Asbestos as it comes from the mine. You can see some of the fibers that have been torn away.

buildings. Anything used to keep heat in or out is called insulating material, or insulation. An asbestos mat insulates the table from the heat of the coffee pot.

In the earth, asbestos appears to be solid rock, but it is really a mass of fibers packed tightly together. The picture shows the rock and fibers. Asbestos occurs in veins that evidently were once cracks. The veins are seldom more than a foot wide and are more often only a small fraction of an inch. The fibers usually extend across the vein. Down to three-eighths of an inch long the fibers can be spun and woven. Shorter fibers are used in asbestos cement, fireproof roofing, and insulating materials.

More asbestos is produced in Canada than in all the rest of the world put together. The principal mining area is in the part of Canada that lies between New Hampshire and Vermont on the south and the St. Lawrence River on the north. The deposit extends toward the southwest into Vermont.

There is much handwork in preparing the better grades of asbestos for use. The long fibers, suitable for spinning, might be broken if machinery were used. Workmen usually break the veins out of the chunks of rock with heavy hammers, called sledge hammers. Then the pieces of asbestos are sorted out of the broken rock by hand. They are dried

and hammered again to separate the fibers. Sifting through screens takes out most of the dust and short fibers.

Where the deposits are made up of fibers too short for spinning, the workmen do not need to be so careful. Then the rock is beaten by machine to loosen the fibers. Dust is sifted out through screens. Suction machines pick up the fluffy fibers, leaving pieces of ordinary rock behind.

Next to Canada, South Africa is the largest producer of asbestos. South African mines could produce more, but only the best grades of fiber are kept and sent to market. Short fibers are thrown away because they would not bring a price high enough to pay the cost of transportation. Transportation costs are very high. The mining regions are sparsely populated and have few other resources. Such regions almost never have railroads and good roads. The mine owners, therefore, have usually had to provide their own transportation. Sometimes they have built railroads, just for their own product. Sometimes they use trucks to carry the asbestos to railroads many miles away. Rhodesian asbestos is taken to the ports of Beira and Lourenço Marques in Mozambique for export. Asbestos from the Union of South Africa is shipped through the ports of the Union.

In addition to the cost of transportation from the mines, there are the freight charges on a long sea voyage. Even the Union of South Africa does not have enough people to give asbestos a very large market. Most of the fiber is used in the industrial regions of North America and Europe. Only the better grades bring a high enough price to pay for the transportation. Therefore the miners of South Africa throw away as waste vast quantities of asbestos fibers that would be sold and used if they were mined in Canada.

Asbestos is mined in large quantities in the Soviet Union. The principal mining region is northeast of Sverdlovsk in the Ural Mountains. There are mines also on the upper Enisei River, about where it leaves

the highlands, and in the Caucasus region. Little of the Russian asbestos is exported.

Some of the oldest asbestos mines are in northwestern Italy. Australia is a fairly important producer, and there are mines in many other countries. In the United States the most important mines are in Vermont and Arizona. United States mines produce only a small part of the asbestos used in United States industry, however. The rest is imported from Canada and South Africa.

Books of rock. Mica is another rock almost as curious as asbestos. You have probably seen it. The little windows that let you see the fire in stoves are made of mica. Mica can be split into sheets. It occurs in the earth in lumps embedded in other rock. Miners call the lumps "books" because they are made up of thin sheets.

Mica is mined in many countries. Some is mined in the Black Hills and other parts of the United States, but not nearly enough for the needs of the country. Most of the best quality comes from India and Brazil.

You may be interested in knowing how mica is used in an industrial culture and how it was used in a nonindustrial culture. Mica has been mined in India for a long time. Careful Indian workmen split it into thin, gleaming sheets. From these sheets they cut pieces to be inlaid as decoration in walls, or they punched out little round ornaments called sequins to be sewn on dresses.

In America and Europe the great use of mica is for insulation in electrical equipment. Here the insulation is not to keep heat out or in, but to keep electric currents from going where they are not wanted. Electricity does not pass through mica.

Many of the mines in India are open pits, sometimes in the form of long trenches that follow the deposits. In many cases the mines are operated by Indian miners who have very little money to put into capital equipment. They dig with hand tools. Instead of using mechanical hoists, they carry the mica out of the mines in large bowls or baskets on

their heads, or they arrange long lines of workers from the bottom to the top of the pit. These workers pass along buckets of the mineral from hand to hand.

There are also underground mines, with shafts and mechanical equipment. Even in some of these mines drilling is done by hand. A miner holds a long steel rod and pounds it into the rock with a hammer. There is a reason for this method. A mechanical drill would pound through a book of mica and the driller would not know the difference. If that happened, the mica would be spoiled. A miner drilling by hand can feel the difference when he strikes mica, and he moves his drill to one side.

In the United States power drills are used. The drills damage a good many books of mica, but the speed and cheapness of mechanized methods more than make up for the spoiled mica. Besides, it is spoiled only for use in large sheets. There are other uses. In the United States very small and

broken pieces are ground. You have probably seen ground mica without knowing what it was, for it is used as imitation snow on Christmas trees. It is one of the substances often put into rubber and roofing materials to give them body. It is dusted between two pieces of rubber to keep them from sticking together, as between the inside of an automobile tire and the inner tube.

For the most part, only the larger sheets of mica are saved in India, for India is not an industrial country. Mica must be exported. In world markets small pieces and ground mica do not bring a price high enough to pay for the work and transportation. In the United States, where the distances between mines and factories are not so great, the less valuable grades of mica still pay for mining and transportation.

Common salt. Did you ever think of salt as rock? A piece of rock salt from the earth looks very much like any other kind of white

Often "chain conveyors" of people line up to pass along bowls filled with mica from the depths of India's open-pit mica mines. Unlike machines, people get tired. Here some, weary of standing, are sitting down.

Michael D. Lyons, Courtesy Engineering and Mining Journal



stone, but it can be dissolved in water. The ocean is salty because of the salt dissolved in the water.

If you dissolve a tablespoonful of salt in a glass of water, it seems to disappear. It becomes a *solution* of salt in water, but it is still there. If you boil away the water, you have the salt again. In many places people get salt by boiling away ocean water or by spreading it out in shallow basins to evaporate in the sun. There are salt springs and salt lakes, too. They are much saltier than the ocean. People get salt from them. But salt in the earth is easier to get and prepare for use.

There are two ways of mining salt. One method is ordinary mining, with shafts and tunnels. The second method makes use of

the ability of water to dissolve salt. The miners drill a well down to the salt deposit and leave it until the water has dissolved some of the salt. Then they pump it out again and evaporate it to get the salt.

Salt is produced in almost every country in the world, either from mines or by evaporating ocean and lake water. Since people must all have salt for their food, you might expect the most densely populated regions to be the ones that produce the most salt. This is not true. The United Kingdom, with about fifty million people, produces and uses nearly the same quantity of salt as China, with eight times as many people. This does not mean that the British people like their food eight times as salty as the Chinese people like theirs. In regions that are not industrialized, salt is used mainly for food. In industrial regions it is also a necessary raw material.

Here men use a drilling rig to drill holes for dynamite into a block of Texas sulfur. Ridges on the block indicate that it has hardened in a vat of corrugated iron.

Ewing Galloway



Sulfur. Do you know what sulfur is? It is a bright yellow material that burns with a beautiful blue flame and a horrible smell. You learned earlier that it is necessary for vulcanizing rubber. Sulfur is used also in fertilizers, in preparations to kill insects, in the manufacture of wood pulp, dyes, and explosives.

There are vast deposits of sulfur near the Gulf coast of the United States, in Texas and Louisiana. These deposits furnish more than nine-tenths of all the sulfur used in the world's industries. Like salt, sulfur is mined by means of wells. Sulfur does not dissolve in water as salt does. Very hot water is forced into the earth to melt it. The miners bore a well down to the sulfur deposits, which are buried from 500 to 1500 feet under the earth. After the sulfur is brought to the top of the ground, it is carried in pipes

to a large vat. The vat may be 1200 feet long and 200 feet wide, with sides made of boards or sheets of metal. The sulfur, still hot, spreads out in the vat a few inches deep. As it cools, it becomes very hard. Then another layer of melted sulfur is added. This goes on until the vat is filled.

After the sulfur has hardened, the sides of the vat are removed, leaving a huge, solid block. Workmen drill holes almost to the bottom of the block and set off explosives in them. The explosions break up a section of the block. Power shovels then scoop up the sulfur and load it on railroad cars.

THE MINING OF METALS

You have read over and over in this book about the people who lived in the New Stone Age. They come into the book so often because they made so many basic inventions. Finally they made one which ended the ages of stone. They discovered metals and invented ways of using them.

From Stone to Steel

Gold was probably the first metal discovered. Unlike most metals, gold exists in many places as pure gold, not a compound. The beds of many streams have gold nuggets like shining pebbles in the gravel.

A Stone Age finder might wish to improve the shape of his pebble, and he would naturally try to do this by hammering it or chipping it. He would expect it to behave like stone. Then he might find that the yellow pebble had a quality that other pebbles did not have and that he could change its shape by hammering it. Most metals can be hammered into shape without breaking. In other words, they are *malleable*. Malleability is one of the qualities that scientists still use to define metal. It is a quality that distinguishes metals from other materials.

Copper and bronze. Gold is not a very useful metal, for it is too soft. The first really useful metal known was copper. It was the discovery of copper, therefore, that began a new culture. No one knows just how it happened to be discovered.

However it happened, people in many parts of the earth were using copper long

before written history began. The oldest copper implements seem to have been cold-hammered; that is, a workman took a piece of copper and simply hammered it into the shape he wanted. Later, the coppersmiths learned that copper can be shaped more easily when very hot. Still later they learned to cast it by melting it and pouring it into molds shaped like the objects they wanted.

The Copper Age did not last long. Somewhere among those inventive people near the eastern end of the Mediterranean, an ancient metalworker made another great invention. He invented bronze. Bronze is an alloy of copper and tin. Any mixture of two or more metals is called an alloy. An alloy may have very different qualities from the metals that go into it. Bronze is a good example. Copper is a soft metal, very malleable; tin is even softer; but bronze, an alloy of these two soft metals, is hard and brittle. It is scarcely malleable at all.

Copper was fairly abundant around the eastern end of the Mediterranean. The Egyptians mined it on the peninsula at the north end of the Red Sea. Other ancient miners worked on the island of Cyprus.

The evidence indicates that some of the first tin may have come from Persia, now Iran. Phoenicians, famous traders from the eastern end of the Mediterranean, began to bring tin from Spain. Still later they got tin from northwestern France and from Cornwall, the southwestern corner of Britain. For little Phoenician ships, a voyage to western Europe was long and dangerous. Traders would not have made it except for

a product of great value. Tin was such a product because Bronze Age culture depended upon it.

The Iron Age. The Bronze Age ended in the eastern Mediterranean region when iron came into general use a little more than three thousand years ago. Iron did not sweep away bronze all at once. People went on using bronze for many purposes. What the coming of iron did sweep away was the old Bronze Age culture.

We do not know exactly how iron was worked at first, but we can guess the techniques of early ironworkers by studying the simplest methods used in our own time. Probably the most primitive ironworking to be found in the world today is carried on by blacksmiths in Central Africa. Iron ore is found in a great many places in Central Africa—not much, usually, but enough for the blacksmith who needs only a few basket-fuls to charge his furnace. The blacksmith and his helpers dig the ore and pile it where they intend to build the furnace.

The blacksmith starts his furnace by digging a shallow hole in the ground. In this hole he places iron ore and charcoal in alternate layers. When it is filled he keeps on adding layers until he has a pile several feet high. Then he plasters clay over the outside, leaving small openings at the base and top for air. The clay forms a cone-shaped furnace with ore and fuel inside.

The fire bakes the clay hard. The blacksmith has to break it away when the fire has burned out. The charcoal and the ore are gone. Only a lump of red-hot iron is left in the bottom of the furnace. It is not melted iron. The ore was a compound of iron with the gas, oxygen. The hot fire drove off the oxygen and left the iron.

While the iron is hot, the blacksmith can shape it by hammering it. If it cools off, he can heat it again without such a hot fire as he needed for smelting. Or, if he wishes, he can let part of the iron get cold and save it to heat and work another time.

In some such way the early ironmakers must have worked. The product they made is called wrought iron. Wrought iron is not very hard, as metals go, but it is tough. Hammering does more than shape the iron. It makes the metal harder and tougher.

The ironmakers improved their furnaces and their techniques, but ironmaking was still a business of heating and hammering. One important new invention was made in ancient times—a simple method of producing steel. It was done by heating the wrought iron in a bed of charcoal and then plunging it into water. Sudden cooling in water hardened the metal.

The same methods were used until the late Middle Ages. Iron and steel became the most commonly used metals in the world. They were used for everyday purposes—farm tools, kitchen utensils, hinges, locks, parts of vehicles, weapons, and thousands of other articles. Still iron was made a piece at a time, shaped on an anvil by a blacksmith with a hammer in his hand. You see, the metalworkers still could not melt iron. They just could not get a furnace hot enough. That invention did not come until the fourteenth century. Then taller furnaces with better draft were built. They were a primitive form of the modern blast furnace. With them iron could be melted and cast.

The Modern Steel Industry

Steel still had to be made a piece at a time. No way was known to make steel from iron that had once been melted. Then in the year 1860 a new device was tried out in Sheffield, England. It was called a Bessemer converter, after its inventor, and its job was to make steel from melted iron. It was a great success. For the first time steel could be made in large quantities.

The Bessemer converters could make the steel faster than the furnaces could supply iron, and so inventors set to work to make a furnace that worked better and faster. The modern blast furnace was the result.

Without the blast furnace and methods of making steel in great quantities, the world could not have become industrialized as it now is. The inventions of equipment and techniques are not part of the story of mining, but the story of mining would have no meaning if you did not understand the use to be made of the products.

The history of iron in America. There were a great many small ironworks in the American colonies. They depended upon many small deposits of ore. The early ironworkers used charcoal for smelting the ore. In time, wood became less plentiful and the demand for iron and steel increased. In America, anthracite was the first substitute for charcoal as a fuel. Its use began in 1840 in the anthracite region of eastern Pennsylvania. About 1870 the ironmakers began to use coke as fuel. Then the Pittsburgh region of Pennsylvania, with its good coking coal, became the center of the industry. At first iron ore came from the Appalachians. But events were already taking place that were to change the iron and steel industry.

In the year 1844 a party of government surveyors were working south of Lake Superior on the Upper Peninsula of Michigan. They were having difficulty because of the strange behavior of their compass. Sometimes the compass needle pointed north, and sometimes it pointed in various other directions. The surveyors were scientists enough to know what the strange behavior of the compass needle probably meant, and they began looking for iron ore. Some iron ores are magnetic and attract a compass needle. The surveyors found large deposits. Mining was begun, but transportation was a serious problem until after the Soo Canal was finished in 1855 and a railroad in 1857.

Soon after the War between the States there was a report that gold had been discovered in the country around the western end of Lake Superior. Prospectors flocked to the region but did not find gold. The mineral they found was a compound of iron

and sulfur. It is yellow and has fooled so many people that it is called fool's gold.

One disappointed prospector carried home with him a little cloth bag of red iron ore. He had found a place where there seemed to be a great abundance of it. It would be valuable some day, he thought, and so he told his four sons about the place.

Those were the days when lumbering was just becoming important in the northern lakes region, as you can see by checking with the graph on page 127. The boys' father had been a lumberman. He went back to lumbering after he had been fooled by the fool's gold. The boys grew up and became lumbermen. For twenty years they worked in the forest. Those were the years during which the Great Lakes line on the graph climbed toward its peak. The brothers made money and saved it.

Just before the lumber business began to decline in the lakes region, the four brothers decided they had enough money. They gave up lumbering to look for their father's find of iron ore. Taking three young nephews with them, they set out to explore and map the area north of Duluth. In one long strip of land the signs of iron were especially plentiful. That was the area they determined to develop. They had discovered the Mesabi Range, the greatest deposit of iron that is known in the world.

The brothers selected the place for their first mine in 1890, but there was still no use in getting out the ore. The great Mesabi Range was of no use to anyone without a railroad to the lake port of Duluth, and so the brothers set out to build one. The distance was only fifty miles, but Duluth was a long, long way from the source of railroad equipment, and railroad building was slow and costly. It was not until 1892 that the first trainload of ore went down to Duluth.

Lake Superior iron ranges. In your earlier study of geography, you learned about the great open-pit mines along the Mesabi Range and how the mining is done. Have

you ever thought of a miner as a man with a pick and shovel? You would not see pick-and-shovel miners on the Lake Superior ranges. Mines there are entirely mechanized. The world cannot afford hand methods in regions with high standards of living.

The long chain of people passing mica from hand to hand in India get only a few cents a day each. In crowded, unmechanized India, the standard of living is low. In highly industrialized countries, standards of living are high. They are high because nearly all the people earn enough money to live well. The ore a miner could dig in a day with a pick and shovel would not be worth nearly enough to pay his wages.

Now look at the population map on pages 374-375. The iron ranges around Lake Superior produce more iron than is produced in any other region in the world, but the population is sparse. You can see why. Mining as it is carried on here does not require a large number of workers. A few men to keep the trains running, a few men to operate the great shovels and drills, a few men to keep the machines repaired, a few men to plan the work—that is about all who actually work in the mines.

When the ore has gone down the lakes to the steel-mill cities, the story is different. In Milwaukee, Chicago, Detroit, Cleveland, Buffalo, Pittsburgh, and in all the smaller cities between, there live millions of people who would not be there except for the iron deposits around Lake Superior.

If you have ever read about the iron ranges in books and magazines, you have probably seen some contradictory statements. Some writers say that most of the ore has been mined—that it will be used up in a few years. Others say the reserves (deposits still in the ground) will last for a thousand years. Strange as it may seem, both statements are true. A large part of the rich ore has been used, but there is still plenty of rock with iron in it.

If you were to drive along the highway that follows the Mesabi Range, you would

see great piles of material that look like high hills. Most of them are yellowish-brown earth, but some are dark red—mountains of broken red rock. The rock is waste material scooped out of the pits, but it has been kept carefully separate from the other waste materials. Those piles of red rock have iron in them. It is not enough to pay the cost of transportation and smelting now, but the miners save the rock when they must dig it up to reach the richer deposits.

Miners save the red rock because it will be valuable some day. When the richer deposits are used up, then either the price of iron will rise, or cheaper methods of transportation and smelting will be worked out. The poorer deposits will be used. A mineral deposit is called ore only if it is worth mining. These deposits are not worth mining now, but they will be mined whenever the need is great enough. Then they can properly be called ore.

Around Lake Superior there are immeasurable quantities of this poorer material. It is underground throughout the iron ranges. It outcrops in great cliffs all over the region. The waves of Lake Superior beat against reefs of it. And so the people who say that there is enough iron to last a thousand years are also telling the truth.

Other iron regions. The second greatest iron-producing region of the United States is around Birmingham, Alabama. It is at the very southern tip of the Appalachians, which have deposits of coal and iron scattered throughout their length. Most of them would not pay for the work of mining and transportation at the present time.

At their southern end, the Appalachian ranges have tapered down to high hills rather than real mountains. Birmingham lies in a valley between two ranges of these low mountains. The iron ore is in Red Mountain, just east of the city. Here the iron is in veins underground. In the same mountain are layers of limestone. Across the valley are deposits of good coking coal.

The coke ovens are at the foot of the mountain ridge that has the coal mines, and the steel mills are beside them.

The iron ore at Birmingham is not very rich. Its iron content is only 35 to 40 percent, compared with more than 50 percent in Great Lakes ore. With present supplies of ore and with present needs for iron, it does not ordinarily pay to mine ore that has only 35 percent iron content.

It does pay in Alabama. It pays because transportation costs almost nothing. In Alabama the three materials necessary for steel-making could not have been placed more conveniently if the arrangement had been planned.

Iron and limestone on one side of a narrow valley, coal on the other, steel mills between them in the valley. Compare this with a steel mill in Gary, Indiana, for example, where ore comes from the Lake Superior region and coal from West Virginia.

Before World War II, the western part of the United States had no blast furnaces and no iron mines. The iron and steel plants of the West got their iron ready-smelted in the form of pig iron—large bars of iron from the blast furnaces. Then the war brought great industries to the Pacific coast, especially shipbuilding. The West needed far more steel than it had ever needed before. In spite of the difficulties that were encountered, mines were opened, and plants were set up to prepare the iron for use.

One of these plants is on Utah Lake, south of Salt Lake City, Utah. You can find the lake on the map on pages 378–379. A new open-pit mine about 250 miles to the southwest supplies ore. Coal comes from a deposit 130 miles to the southeast. Limestone is quarried about 25 miles away.

The other new iron and steel plant was built a few miles inland from Los Angeles. Ore for this plant comes from new mines



Courtesy Tennessee Coal, Iron and Railroad Company

Here one huge machine, loading iron ore underground, does work that would require many workers in unmechanized mines.

located in southern California. Coal comes from the mines located in Utah.

There is no very large iron and steel industry in North America outside of the United States. Canada has many deposits of iron ore, but iron is not mined on a large scale. Part of the Canadian steel industry depends upon ore from the United States. Steel mills in Nova Scotia get their ore from mines near the eastern tip of Newfoundland.

The largest iron and steel industry in South America is in the highlands northwest of Rio de Janeiro. A large steel mill was begun there in 1940 and finished in 1946. The iron ore is mined near by, but there is not enough coal. Some of the coal is brought from the United States. Prospectors are exploring the region for coal deposits and expect to find enough coal to meet the needs of the industry.

In western Europe the Lorraine field, in eastern France and Luxembourg, is the largest and has produced the most iron. But industrial Europe has many other iron deposits, and every country has an iron and steel industry. One of the world's richest iron deposits is at Kiruna, in northern Sweden. The railroad from Lulcå, on the



Eric Hess from Triangle Photo Service

Already the new Volta Redonda iron and steel industry in Brazil is South America's largest; still Brazil's government plans to enlarge it. Here a technician shows his son its plant and the workers' houses.

Gulf of Bothnia, to Narvik, in Norway, was built to carry ore from the Kiruna mines. Sweden does not have supplies of coal and so its steel industry is not large.

The Soviet Union has two iron and steel regions. The one at Magnitogorsk depends upon a whole mountain of iron ore. The ore is mined by terracing back the mountain slope. Mining is entirely mechanized, and the machines are operated by electricity. Coal comes from the region around Karaganda to Magnitogorsk, where the steel mills are located. You can find these cities and the railroad which connects them on the map of Eurasia, pages 388–389.

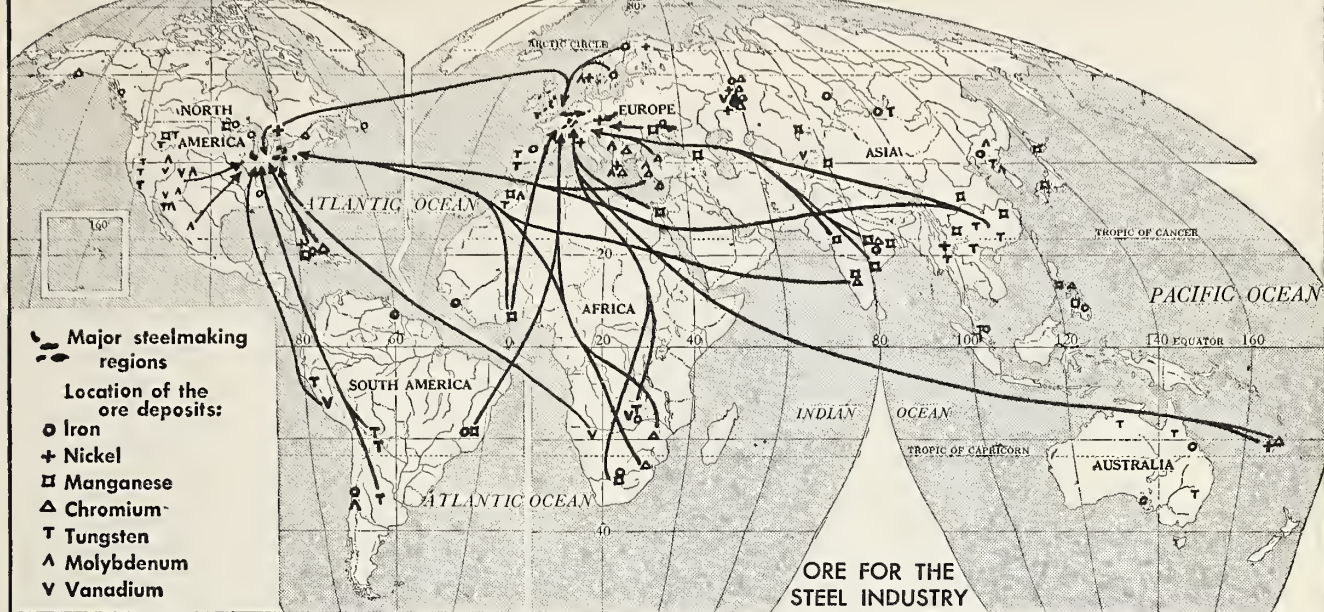
The other great iron and steel region is in the southern Ukraine. Iron comes from mines near Krivoi Rog and on the Crimean

Peninsula. It is smelted with coal from the Donets Basin. For these places, look on the map of Europe, pages 386–387.

Far to the east in Asia, there is a huge open-pit iron mine in Manchuria. It is located at the edge of the highlands, just east of Mukden. Coal comes from a large open-pit coal mine that is located near by.

Steel Alloy Metals

For more than three thousand years people have used iron. During most of that time they have known how to make steel from iron. Their steel varied in quality according to the quality of the iron ore and the skill of the workers. There was good steel and poor steel, but there were no different kinds of



Sources of iron and alloy metals for the great steelmaking regions. Lines do not show actual routes.

steel for different purposes. Now nearly all our steel is alloy steel. The alloy steels differ according to the use to be made of the metal. Many of them are no more like ordinary steel than bronze is like copper.

The map on this page shows you the great steelmaking regions of the world and where the industry of each region gets some of its alloy metals. You can read the names of the principal alloy metals from the map.

Nickel. Nickel was the first metal alloyed with iron to make steel. In the 1890's scientists discovered that nickel alloyed with iron made steel that was harder and much tougher than plain steel. Toughness in a metal is the opposite of brittleness. The metal does not break easily. Nickel steel is used in machine parts that must stand very hard usage; for example, it is used in the crankshafts of automobiles and trucks. Because of its toughness it can be drawn into very fine wire. It makes possible the small compact watches of our time. For the hairsprings in

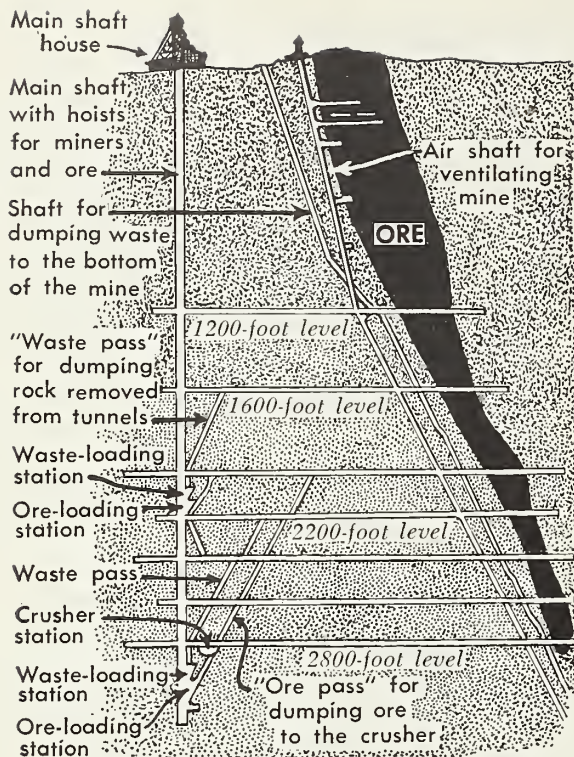
those watches, nickel steel is drawn into wires much thinner than one of your hairs.

As the map shows, nickel is not found in many places. More than three-fourths of the world's nickel is mined in Canada. The second most important deposits are on the island of New Caledonia, east of Australia.

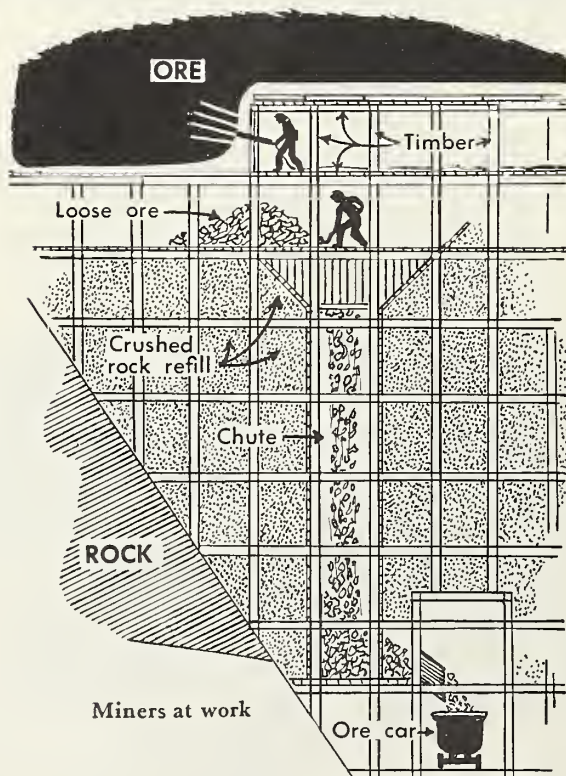
Freight cars loaded with nickel ore wait outside the shaft that leads to one of Canada's remarkable ore deposits.

Courtesy The International Nickel Company of Canada, Ltd.





Cross section of a nickel mine



Courtesy The International Nickel Company, Inc.

In Canada, nickel comes from one of the world's most remarkable ore deposits. There are great masses of nickel and copper ore, with a little gold, silver, platinum, and other metals all mixed together. Miners dig up all the mixture at once. There is no way to separate the ore of one metal from the ore of the others.

The masses of ore are narrow and deep. Some mines go down for two-thirds of a mile. Diagrams on this page show how the work is done in one mine. The main shaft goes down, not into the ore, but into the rock to one side. Tunnels run from the shaft to the ore. In the shaft are hoists, or elevators, to lift the men up and down, and large buckets to raise the ore. Machinery to work the hoists is in the building at the top of the shaft. Nearer the ore is an air shaft. Air is pumped down so the miners will have fresh air to breathe. The third shaft is for dumping crushed rock back into the mine.

Now look at the second drawing. It is a close-up view of miners at work. The dotted area shows where the ore has already been taken out and the space filled with crushed rock. The white bands represent the timbering. In nearly all underground mines, the walls and roofs are braced and supported with timber. The mining industry is one of the most important users of wood.

The miner at the top is drilling holes in the ore. The drawing is simplified. Actually a number of drillers would be working at once. All day long the drillers make many holes, and blasters place explosives in the holes. At the end of the day they light the fuses of the blasting powder and everyone leaves—fast! The blast knocks down a whole section of ore, which falls through an opening to the level below. When the miners of the next shift come to work, their first job is to extend the timbering into the area that has just been blasted. Then they begin drilling new holes.

Down below, other miners are shoveling and pushing the ore into the chute that leads to a car in the tunnel below. When enough

cars are filled, a little electric locomotive hauls a train of them through the tunnel to the main shaft. There the ore is dumped into a crushing machine to break up the larger pieces. Then it is placed in huge buckets that are hoisted to the surface, where the worthless rock is removed. The rock is dumped back into the mine to fill up the space left when the ore was taken out.

Manganese. All modern steel has a little manganese in it. For some uses of steel, much more manganese is added. It makes the steel very tough. High-manganese steel is used in the big dippers on power shovels, in rock-crushing machinery, in scrapers, plowshares, car wheels, rails, dredges, and many machine parts that must stand hard wear.

Now turn back to the map on page 159 to see where the great steelmaking regions get their manganese. In the United States, manganese is produced in several places, especially in the Lake Superior iron region. The ore is not of the best quality, however, and a better quality is imported.

Of the great steelmaking regions of the world, only the one north of the Black Sea in the Soviet Union has a plentiful supply of manganese close at hand.

Chromium. Chromium is another very important alloy metal in steel. The alloy is called chrome steel. Like nickel and manganese, chromium adds to the strength and hardness of the steel, but it has a still more important use. If you have ever seen a piece of iron or steel that has been left out in the weather, you know that iron rusts. Even when they are not exposed to the weather, iron and steel corrode. They turn black and the surface becomes rough.

When you go home, look at the knives in your kitchen and see if some of them are not stamped "stainless." Or go to a hardware store and ask to see implements of stainless steel. They are bright and shining. Stainless steel is a chromium alloy. Pure chromium is used also for plating steel. The

shining metal trimming on most automobiles is chromium-plated steel. A very thin layer of chromium keeps the steel from rusting.

Chromium comes mainly from regions that are not industrialized, and so it must be shipped long distances. Of the great steel-making countries, only the Soviet Union has enough chromium to meet its own needs.

On the map on page 159, a long line points to the steelmaking regions of the United States from chromium mines in Southern Rhodesia. The deposits are in a narrow strip of land many miles long. Mines near the northern end of this strip are within reach of a railroad leading to the port of Beira. You can find the railway on the map of Africa, pages 390-391. From farther south, trucks carry the ore to the railway, a long distance over poor roads. Most mining is done by hand as there is no power for machines. Americans and Europeans manage the mines, but the miners are Africans.

Tungsten. Tungsten is also an important alloy metal in steel. It has a very high melting point; that is, it does not melt or even soften until it becomes extremely hot. Its high melting point is the quality that gives it most value as an alloy.

You probably know that the working parts of machines for cutting, grinding, and chipping steel become very hot. If you ever visit a machine shop, don't pick up a chip or shaving of steel that has just flown out of the machine. It will burn your fingers. The chip of steel has been cut just once, but the cutting tool in the machine goes on chipping away all day. Most steels—even most alloy steels—would soften and lose their cutting edge. Because of the high melting point, tungsten-steel tools stay sharp even when they are red-hot.

Tungsten is not mined in many places. There are mines in central Idaho, Nevada, northern Colorado, and at the edge of the Mojave Desert in southern California. You can find the deposits in the rest of the world by looking at the map on page 159.



Courtesy Vanadium Corporation of America

Only a very valuable material makes it worth while for people to work in country such as this. The buildings beside the lake belong to the concentrating plant of the world's largest vanadium mine, high in the Peruvian Andes. The mine itself is still higher in the mountains.

Molybdenum. One other alloy metal can take the place of tungsten for some purposes. It is a metal with a hard name—molybdenum. Molybdenum steel is used in machines and in parts for automobiles and trains. As you can see on the map on page 159, many countries produce molybdenum; but nine-tenths of the world's supply comes from one mine high in the Rockies in Colorado.

Vanadium. Vanadium makes steel hard, but not brittle. Vanadium steel can stand repeated bending, twisting, and strains, as in heavy springs and automobile axles.

On the high plateaus of Peru is the world's largest vanadium mine, at an elevation of 15,400 feet above sea level. That is higher than the highest mountain peak in the United

States. The air is so thin that people from lowlands cannot get enough breath to do hard work. Only Indians of the region can work in the mine. They have breathed this thin air all their lives and have developed larger lungs than other people have.

The ore is carried on a steep railroad from the mine to a lake four and one-half miles away. There it is separated from some of the waste materials—concentrated is the correct mining term. The concentrates are loaded on barges, which are towed six miles across the lake by boats with Diesel engines. On the other side the concentrates are loaded on the cars of another railroad and taken to the port of Callao for shipment.

There is also a large vanadium deposit in the United States, where Colorado, Utah, Arizona, and New Mexico meet. Small

mines are scattered over the area. Trucks carry the ore from all the mines to a smelter in southwestern Colorado.

You can see on the map where else in the world vanadium is mined. It comes from that amazing region in Southern Rhodesia where so many other minerals are mined. It comes also from Southwest Africa, which has few other valuable resources.

Many Metals

Many different metals are used in the world's industries. Iron and steel are the very foundation of modern industry, but there are other metals that we could hardly do without. One of these is the oldest of all industrial metals, copper.

Copper. In the past, ease of working was the important quality of copper. Today it is valued because electric current passes through copper more easily than it passes through most metals.

Copper goes into every piece of electrical equipment used in homes and factories. It goes into the great generators that produce electricity in hydroelectric plants. It goes into the wiring and ignition system of automobiles, trucks, and airplanes. Radio, television, and radar use copper in their equipment. This industrialized world depends upon steel and its alloys for its machinery, but without copper it would not have the power and the delicate instruments to keep its machinery in operation.

The first important copper-mining region in the United States was south of Lake Superior, at the base of the large peninsula that juts into the lake—the Keweenaw Peninsula. Lake Superior copper ore is beautiful. It is not a compound. Flakes and veins of metallic copper shine from their setting in gleaming white rock. Indians used the copper before Europeans came to the Americas. French missionaries and fur traders saw it, but mining in this region did not begin until 1845.

In spite of the fact that the copper is easy to get from the rocks, the mines are not so important as they used to be. The miners have followed the ore very deep into the earth. Some of the mines are more than a mile deep. Mining so far underground is costly, and so other regions have become more important as producers.

In the great nickel-mining region of Canada, copper ore is mixed with the nickel ore. There is another copper-mining area around Butte, Montana. The city is made up mainly of miners and other people who work for the mining companies and of people in the service industries who take care of the needs of the mine employees.

Arizona and New Mexico have a number of copper deposits grouped near one another. The largest mine in this area is at Bisbee, Arizona. It is southeast of Tucson, and only a few miles from the Mexican boundary. At Bisbee there is a whole hill of copper ore. The ore is dug away in terraces from the side of the hill. This kind of mine is properly called an open-cut mine rather than an open-pit mine.

Most of the mines in the Southwest are shaft mines, though there is a very large open-pit mine in east-central Nevada. In Utah there is a copper region a few miles south of Great Salt Lake, around Bingham. In Bingham Canyon is one of the largest copper mines in the world. The little mining town of Bingham is at the bottom of the canyon. The mines are on the slopes, and again there are great terraces that have been cut back into the mountainsides.

In addition to the regions mentioned, there are copper mines in Alaska, western Canada, and Mexico; but the other really great American copper-mining region is high in the Andes, in Chile. The largest mine is at Chuquibambilla, shown on the map on pages 384-385. It is an open pit, and mining is done with electrical machines. Power comes from the western slopes of the Andes. Other mines in the same region are shafts that have been tunneled into the mountains.

This is a cold, wild mountain area, very dry and almost without vegetation or population. Check those statements with the maps in the back of the book. Mining companies had to bring miners to the region and provide them with houses, light, hospital service, and schools. Some little mining towns are in valleys; others are perched on steep mountain slopes with snow-capped peaks rising around them.

For contrast, turn now to the map of Africa on pages 390-391. Find the part of the southern Belgian Congo called Katanga. There, extending southward into Northern Rhodesia, is another of the great copper-mining regions of the world. In addition to the large deposits of copper, there are de-

posits of tungsten, vanadium, zinc, and several other metals in the same region.

The Soviet Union has an important copper region extending westward from Lake Balkhash. Just north of the lake, there is a whole hill of copper ore rising from a plain. In 1938 the Russians began the development of another region a little farther west. They opened up three open-pit mines and three shaft mines, built a hydroelectric plant for power, a smelter, workshops and factories, a railroad, and houses for the workers. All this happened in a sparsely populated desert region where a few years ago the only people were nomadic herdsmen.

Do you remember how ancient peoples learned to make the hard metal, bronze, from

One of the great copper mines of Chile. On the bare rock of this steep mountain slope it was hard to find a place even for the necessary buildings. Transportation, too, is very difficult.

Courtesy Braden Copper Company and Pan American Union



copper by alloying it with tin? Bronze still has many uses, but modern industry has a still harder alloy of copper. It does not have a simple name like bronze, but is called beryllium copper because the alloy metal is beryllium. It is a gray metal, light in weight and easily broken; but 2 percent of it added to copper makes the copper as hard and strong as most steel. Beryllium copper is used for springs and other articles, but its most important use is in mining tools. Many mines are dusty, and dust will explode if a spark comes in contact with it. You probably know that steel struck against a rock makes a spark. In unusually dusty mines a spark from steel tools might set off an explosion. Beryllium copper is hard enough to replace steel in the tools, and it does not cause sparks.

The United States has beryllium mines in the Black Hills of South Dakota. Smaller quantities are mined in Colorado, New Mexico, and several other states. More is produced in Brazil than in any other country, but there are mines in Argentina, Australia, India, Africa, Portugal, and Spain.

Tin. Tin, as you know, is one of the old, old metals, used before history began. It is still one of the world's most important metals. We still use the old alloy, bronze—for example, in machine parts and bell metal.

Nothing else made of tin is so important as the common, everyday tin can. Tin cans are made from very thin sheets of steel plated with tin. Steel, you know, rusts and corrodes. In steel cans food would be spoiled, but the acids in food have no effect on tin. The thin coating of tin keeps the food away from the steel, while the steel makes the cans strong and stiff.



D. Hosmer from Triangle Photo Service

Tin mining in the hills of Malaya. Ore and gravel have been washed down from the hillside. The swift stream of water carries away the gravel, leaving the heavier tin ore behind.

The United States and Canada, with all their great mineral wealth, have no known deposits of tin worth mining. Except for a little mixed with other ores and separated out as a by-product, they produce none. Mexico produces a little, used mainly to make novelties for exports.

The only large deposits of tin in the Americas are in Bolivia. There the mines are high in the mountains, some of them more than 15,000 feet above sea level. As in the vanadium mine of Peru, the miners are Indians who are used to the altitude.

Southeastern Asia is an even greater tin-mining region than is Bolivia. There are mines in southern China, Burma, Indochina, Siam, and Malaya and also on the islands of Bangka and Belitung near Sumatra.

Compared with the cost of mining in the high mountains of Bolivia, tin mining is

inexpensive in southeastern Asia. Most of the pieces of ore are mixed in gravel in valleys and in the beds of rivers. Along the rivers in Burma and on the islands, huge dredges scoop up the ore. Dredges are used in Malaya, too, but there some of the ore deposits are on hillsides. Streams of water from large hose are thrown against the hillsides. The water tears down the deposits and washes away the ore.

Most of the tin mined in southeastern Asia is smelted near the mines. Bars of pure tin are exported. Most Bolivian ore and also ore from mines in Nigeria used to go to England for smelting. There was no large tin smelter in the Americas. Can manufacturers in the United States bought their tin ready-smelted from southeastern Asia.

Then came World War II. The United States could no longer get tin from Asia. It

was still possible to get Bolivian ore, but there was no smelter. The United States government built a huge smelter in Texas City, which is near Houston, Texas, and so the Americas now have a tin smelter.

Aluminum. From tin, one of the oldest metals, we turn to aluminum, which is the newest of the metals that are used in large quantities. It was discovered as a metal in 1825, but the only way known to extract it from the ore was very costly. In 1885 an American college chemistry student, Charles Martin Hall, only twenty-two years old, invented the process that gave the world cheap aluminum. Strangely, a Frenchman invented the same process at the same time.

The first products made by the aluminum manufacturers were cooking utensils. It was the quick-heating quality of aluminum

Fully mechanized mines deep in the tropical forests of Surinam help to supply American industries with aluminum. Here an American-made power shovel scoops up the ore and dumps it in a railroad car.

Courtesy Netherlands Information Bureau



that sold it to the housewives. Now manufacturers use it for its lightness. Airplanes are made largely of aluminum and its alloys. Airplane wings of a given size will carry just so much weight. The less the plane itself weighs, the more weight it can carry in passengers and freight. Fast trains, automobiles, and trucks are made partly of aluminum, too, because of its lightness.

Aluminum is rather soft. For strength, it is alloyed with a little copper. The alloy, called duralumin, is as strong as steel. Aluminum does not corrode, but unfortunately the alloy does. Articles made of it are given a thin coating of pure aluminum to protect them.

The common ore of aluminum is bauxite. The country with the largest known deposits of bauxite is Hungary, but most of the countries of southeastern Europe have aluminum mines—Yugoslavia, Greece, and Romania. They are not highly industrialized countries, and so use little of their own aluminum. Italy and France have both mines and an aluminum industry of their own. The Soviet Union has several deposits, the largest on the eastern slopes of the central Ural Mountains. Bauxite is mined on Jan Mayen Island, which belongs to Norway. You can find it just east of Greenland on the map on pages 382–383. How would you like to be a miner in that latitude? It would probably be no worse than working in another region with large deposits—a region of dampness, heat, snakes, and insects in the tropical lowlands of Surinam, British Guiana, and Brazil.

Most of the aluminum ore that is produced in North America is mined in Arkansas. It is not enough, though, for the great aluminum industry of the United States. Large quantities of ore are imported, especially from Surinam.

Lead. Another metal that has been used a very long time is lead. It is heavy, soft, and has a very low melting point. These are the qualities that have made it useful. From ancient times people have used it for scale

weights. They have made it into pipes and flattened it into sheets for roofing.

Lead is still used for pipes and roofing. One of its important present-day uses is in type metal. Type metal must have a very low melting point because it is kept liquid over a small flame in the machine that casts type. Two lead compounds are widely used pigments in paint. One of them is white and the other is bright red.

Lead ores are widely distributed. Every continent has deposits, and almost every country. In the United States about half the lead is mined in a region that extends from northeastern Oklahoma and southern Missouri northward into Wisconsin.

The second most important lead-mining region of the United States is in the mountains of northern Idaho. North of this region, just over the boundary in Canada, are still larger deposits.

Zinc. Most areas with lead deposits have zinc deposits also. Zinc is mined with lead in Oklahoma and southwestern Missouri. Like lead, it is mined in northern Idaho and over the border in Canada. Almost every region in the world that has one of the two metals has the other also.

One exception is northern New Jersey. Zinc occurs there without the ore of any other metal. The first zinc mine in the United States was in this region. It is still a large producer of zinc.

Zinc has a great many uses in industry, but you do not often hear the name. Zinc products appear under other names. Sheets of steel coated with tin are called tin plate, but sheets of steel coated with pure zinc are called galvanized iron. Vast quantities of galvanized iron are used to make roofs and even whole buildings. Galvanized wire is the commonest of all fencing materials. You may have a galvanized-iron washboard or pail in your own home without knowing that you have ever seen zinc.

You have probably seen and used brass many times. Did you know it is an alloy of



Courtesy The New Jersey Zinc Company

A New Jersey zinc miner drilling holes for explosives. His drill is held firm by a post that extends from the floor to the roof of the mine. The hose brings compressed air to operate the drill.

copper and zinc? In a hardware store you can find a great variety of brass hinges, locks, bolts, curtain rods, and drawer handles. Brass is also used in a great many machine parts that you do not see.

Pure zinc has many uses, too. It is used in batteries, automobiles, and radios. Plates that are used for printing drawings and maps are made of zinc. The drawings on page 160 were printed from zinc plates.

Gold and silver. Perhaps you have been wondering why gold and silver have not been described. As industrial metals they are not very important. Both are used in jewelry and for watches and ornaments. Silver is used in larger quantities than gold. Most of

our table knives, forks, and spoons are made of silver or of white metal plated with silver. A silver compound is necessary in photography. It coats films and the sensitized paper on which photographs are printed. Silver compounds are also used as antiseptics.

Gold and silver are called precious metals. They are not the most valuable metals known, but they were when the name was given them. Since ancient times they have been used for money. Our dimes, quarters, and half dollars are made of an alloy that is mainly silver. Silver dollars are used in the West but are seldom seen in the East.

Gold has had a great influence on history. Exploration would have been much slower if the hope for gold had not drawn explorers

into new lands. In your history books you have read about the forty-niners, who rushed to California after the discovery of gold in 1848. The gold they found was not especially important to history, but the gold rush was. It led to the settlement of the West. Other parts of the West, in both Canada and the United States, were settled first by gold and silver miners.

Every continent has gold and silver mines. Much silver is also produced as a by-product. There is usually silver ore mixed with lead

ore. The ore that is taken from the great nickel-copper mining region of Canada has both gold and silver in it.

More than half the world's gold comes from South Africa, near Johannesburg. This is the region known as the Witwatersrand or, more often, "The Rand." The word "rand" means ridge or edge in Dutch and refers to a ridge of rocky hills which are the edge of great tilted blocks of rock. Gold mines extend for fifty miles along this ridge. Some are almost two miles deep.

FUELS FROM THE EARTH

You have read that the industries of this working world would not be possible without iron and steel. You have also read that they would not be possible without the steel-alloy metals that are used to make tough, sturdy, high-speed machines. You have seen that an industrialized world needs copper to carry its messages, its light, and its power. Now you are going to learn that modern industry would not be possible without fuels from the earth—coal, oil, and gas.

Coal

You have been reading about coal ever since you began to study geography. You have read about soft, or bituminous, coal and hard coal, or anthracite. You have read about a soft brown coal called lignite, and about a fuel called peat that is used in northwestern Europe. You probably have a general idea what these various terms mean, but to understand them fully you need to know how coal was formed in the earth.

What is coal? Geologists are scientists who study the materials of the earth. They are able to read the rocks just as you are able to read a map. This is the story of coal, as they read it from the rocks.

There have been times when the earth was much warmer than it is now. During those

times, very thick vegetation grew on the earth. Leaves fell to the ground and partially decayed, as they do now. Trees and smaller plants fell. On page 135 you read about the layer of humus that forms wherever there has been vegetation for a long time. Plant remains decay less rapidly where they are under water than they do where they are sometimes wet and sometimes dry. When they fell in the swamps of long ago, they piled up, becoming solid and more compact all the time.

Layers of partly decayed plant materials are still accumulating on the earth. When they have become solid and compact, we call them peat. Peat is the first stage in the formation of coal.

Sometimes the land sank far enough to flood the peat marsh with water. Rivers brought sand and clay and buried the plant materials. Mollusks lived and died in the water. Their shells sank to the bottom and sometimes piled up many feet thick.

The layers above the peat became very thick and heavy. Pressure slowly changed the peat into coal. First it became lignite, which is a soft, brown coal. Pressure and the movement of one solid material against another produce heat. When the plant remains have been squeezed and baked, they become soft coal. Still further heat and pressure change soft coal into anthracite.



Location of coal deposits and regions of coal mining in the United States and southern Canada.

Where coal is mined. The map on this page shows where coal deposits are found in industrial North America, and where coal is mined. There are coal deposits under thousands of square miles of land, but the mining regions are comparatively small.

In general, coal mining does not differ greatly from other mining. Where possible, the coal is dug from open-pit mines. In the coal industry, these are usually called strip mines. Where open-pit mining cannot be carried on, shafts and tunnels are dug. One special kind of underground mine is common in the coal-mining region of the Appalachians, particularly on the Allegheny Plateau.

The plateau was formed by the rising of a large block of land. There are layers of coal between the other rock layers. Where the valleys cut through coal seams, the coal crops out on the slopes. Many mines are tunnels running horizontally into the coal seams, with the entrance at the outcrop on

the hillside. These are called drift mines. They are easier to operate than shaft mines because the coal does not need to be hoisted up a shaft.

There are many drift mines in West Virginia and Pennsylvania, the two states that produce the most coal. Some of the rivers are used for transporting coal. Whether or not the river is navigable, a railroad usually follows the bottom of the valley. Very often the coal can be carried on conveyors from the mine to river barges or coal cars at the bottom of the valley.

Mechanized mining. On the whole, no other American mining industry is so highly mechanized as the coal industry. Some of the machines are the same as machines used in other kinds of mining. Others have been invented especially for the coal industry. This is particularly true in the underground coal mines. In most strip mines, machines

are much the same as those that are used in other open-pit mines.

A technique called the room-and-pillar method is commonly used in coal mines. When a new section of the coal seam is to be mined, the miners first open up tunnels to the farthest point in the new area. Teams of workers follow close behind them, putting in the timbering. Next a team of workers installs the ventilating system. This is usually made up of large canvas tubes through which air can be forced into the mine.

Then, when the necessary transportation equipment has been put in, the miners are ready to go to work. They work in small groups. The first job is to undercut a section of the coal. The undercut is a gash about

six inches wide that is cut into the bottom of the coal seam. It runs back into the coal perhaps as much as nine feet.

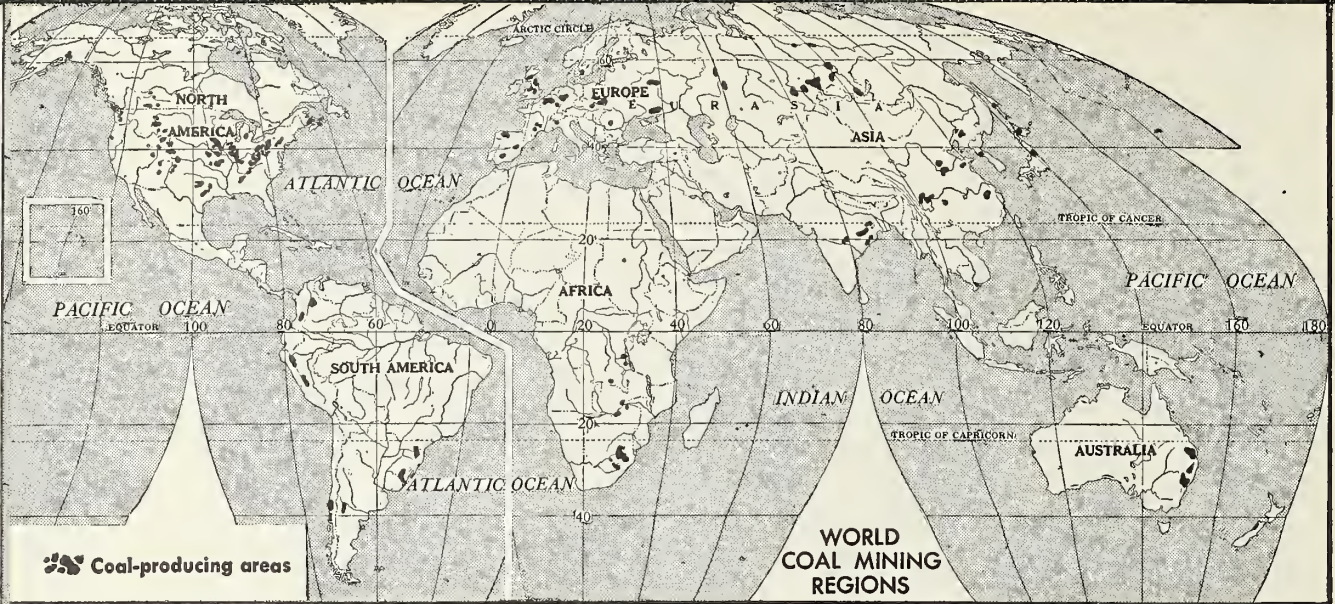
The most up-to-date machines for undercutting coal are mounted on caterpillar treads and driven like a tractor. Extending in front is a heavy plate of steel. Around the edge runs a chain with teeth of hard steel projecting from it a few inches apart. When the power is turned on, the chain goes rattling around the steel plate at high speed. The teeth cut into the coal.

When the undercut has been made, a team of drillers begins to work. When enough holes have been drilled, the drillers leave and the blasters come. The undercut makes the blast much more effective. Without it, the

The electric lights that illuminate this section of an underground coal mine make visible the timbering that supports the roof of the mine. The coal-loading machine to which these lights are attached has pushed blasted coal up its slanting platform to a conveyor that will carry it to a waiting coal car.

Courtesy Goodman Manufacturing Company





Location of the world's coal-mining regions.

explosives would merely shatter the wall of coal. With it, the coal is knocked down into the space left by the cut.

In some mines the loosened coal is still shoveled by hand into small cars that run on railroad tracks. In fully mechanized mines the loading is done by machine. One kind of loader is shown in the picture on the preceding page. A wide, slanting platform is pushed under the coal that has been blasted down. Whirling steel arms gather up the coal and push it up the platform to a conveyor that carries it over the machine to the coal car. Electric locomotives pull the cars to the entrance of a drift mine or to the bottom of the shaft in a shaft mine.

Another kind of machine for getting the coal out is called a shaker conveyor. It is a steel trough made in sections. A mechanical scraper may bring the coal to the end of the conveyor. The sections of the shaker conveyor move in short jerks that slide the coal along the polished steel trough.

In some mines the coal is carried underground on trough-shaped belt conveyors. Coal may be carried several miles by these conveyors, from the working place to the mouth of the mine.

Near the mouth of a mine is a building for cleaning and loading the coal. Suppose

it is a drift mine, on a valley slope cut into the Allegheny Plateau. A long covered conveyor leads to a large building at the foot of the slope. Railroad tracks—several of them—run under the building. Rows of coal cars wait on the tracks.

The coal comes into the building at the top. First it goes through a machine that washes it. Next the coal is sorted. It moves along over screens that have holes in them. First there are small holes. The very fine coal drops through them to conveyors below. Then a larger size drops to another conveyor; and so on until the pieces of coal are all sorted. The conveyors carry the coal to the waiting freight cars. Each car is loaded with just one kind of coal.

American coal mines are the most highly mechanized in the world, and even in America only about half the mines use all the machinery described. Of course, drills, blasting, and mine railroads are used almost everywhere. The main reason for mechanization is to increase each man's production. In regions where wages and standards of living are low, employers usually hire more men instead of buying machines.

In other places the machines cannot be used. This is true in many of the coal mines of western Europe, especially in Great

Britain. In British coal fields there are few thick coal seams. A seam may be only a few inches thick. Then there is a layer of rock, then another thin layer of coal, then another layer of rock. It is not possible to undercut and blast out a seam of coal six inches thick. The rock tumbles down along with the coal. A man with a shovel sorts out the coal and leaves the rock. A machine loads everything in its path.

Fortunately, coal is widely distributed. The map on the facing page shows where coal is mined. There are other deposits not used at present. Little coal is mined in regions that are not industrialized.

Conservation. Should coal be conserved? Yes, in the sense that conservation means wise and careful use, all natural resources should be conserved. If the people of the United States went on using coal at the rate they use it now, there would be enough coal to last for three or four thousand years. That would take us as far into the future as the Bronze Age is in the past. Even so, it should not be wasted. Much of the coal is poor in quality or hard to mine or far from industrial regions. Such coal would be costly to mine and transport.

Petroleum and Gas

Much of our industry depends upon coal, but much of our transportation depends upon petroleum. Petroleum products run our airplanes, automobiles, trucks, and many of our trains and ships. Besides its use as fuel, petroleum is a valuable raw material in industry. Hundreds of products are made from it—plastics, paints, antiseptics, paraffin, asphalt, insect poisons, and a great many others. One of the most important is synthetic rubber.

Scientists are not absolutely sure how petroleum got into the earth. They are certain of one thing. It came long, long ago from the remains of plants and animals. They think that dead sea animals and plants

were washed into hollows in the ocean floor. Animal and plant remains from the land were carried down by rivers and added to those from the sea. Then these remains were covered with earth materials. Pressure and heat over a long, long time brought about chemical changes, and part of the remains became oil. Where there are porous rocks such as sandstone near by, these rocks have soaked up the oil like a sponge.

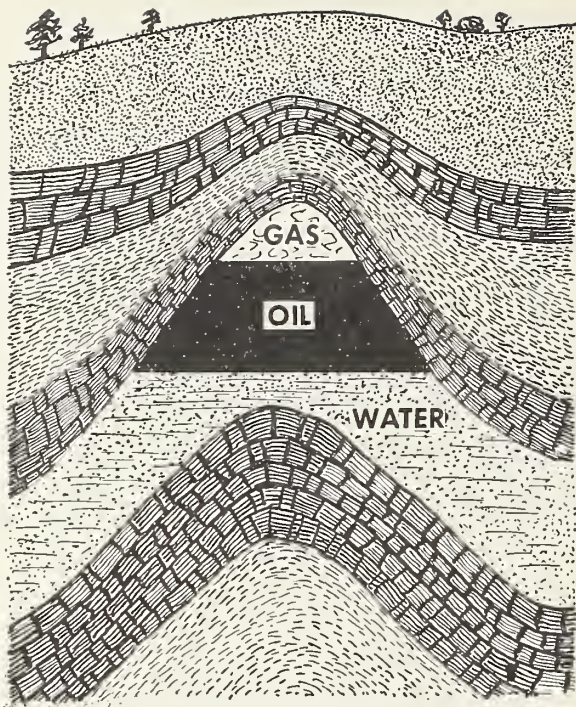
Oil wells. As you know from your earlier study of geography, petroleum comes from wells. Petroleum is usually called oil, and the wells are always called oil wells. The first oil well in the United States, drilled in 1859 in Pennsylvania, was $69\frac{1}{2}$ feet deep. Some of the wells drilled today are more than three miles deep.

Early wells were drilled with a tool that pounded its way into the ground. It was a huge chisel-shaped tool on the end of a cable which ran through a pulley at the top of a tall derrick. An engine raised the bit and dropped it, over and over. Now rotary drills are used for most wells. Instead of being raised and dropped, they turn round and round, grinding their way down.

The drillers fasten the bit to the end of a pipe. An engine keeps it turning round and round. The derrick is still needed. A cable from the top of the derrick is used to raise the pipe. When one length of pipe has sunk into the earth, another is lifted and screwed on the end.

The drillers cannot just attach a bit to the end of a pipe and keep on going down, adding new lengths of pipe as they are needed. Drill bits become dull and must be replaced. Then the whole length of pipe must be pulled up. To pull up a mile of pipe, the drillers have to unscrew about thirty joints. After the drill is changed, all the sections must be screwed together again.

If all goes well, the drillers strike oil after a time. The drill grinds its way through a layer of hard rock into the porous sandstone that holds the oil. Sometimes the



oil is under such great pressure that it shoots out of the top of the well. Usually, however, it rises more slowly.

While the wells are being drilled, an oil field is a busy place. Later it looks deserted. Usually the derricks in an oil field are left standing, in case there might be any need to pull the pipe out of the well. You can look across an oil field and see no one at all—just pumps working slowly up and down under the derricks.

Exploring for oil. In the early days of the oil industry, there was no way to find oil except by drilling a wildcat well. A wildcat well has nothing to do with wildcats. Oilmen use the term for a trial well. Fifty years ago not one wildcat well in a hundred struck oil. Now the percentage is about one in ten. The difference in the percentage of successful trials is due to the work of scientists. They have found out much more about where to look for oil, and they have invented new instruments for exploring.

Oil occurs only in areas that were once old sea bottoms. Scientists now know much

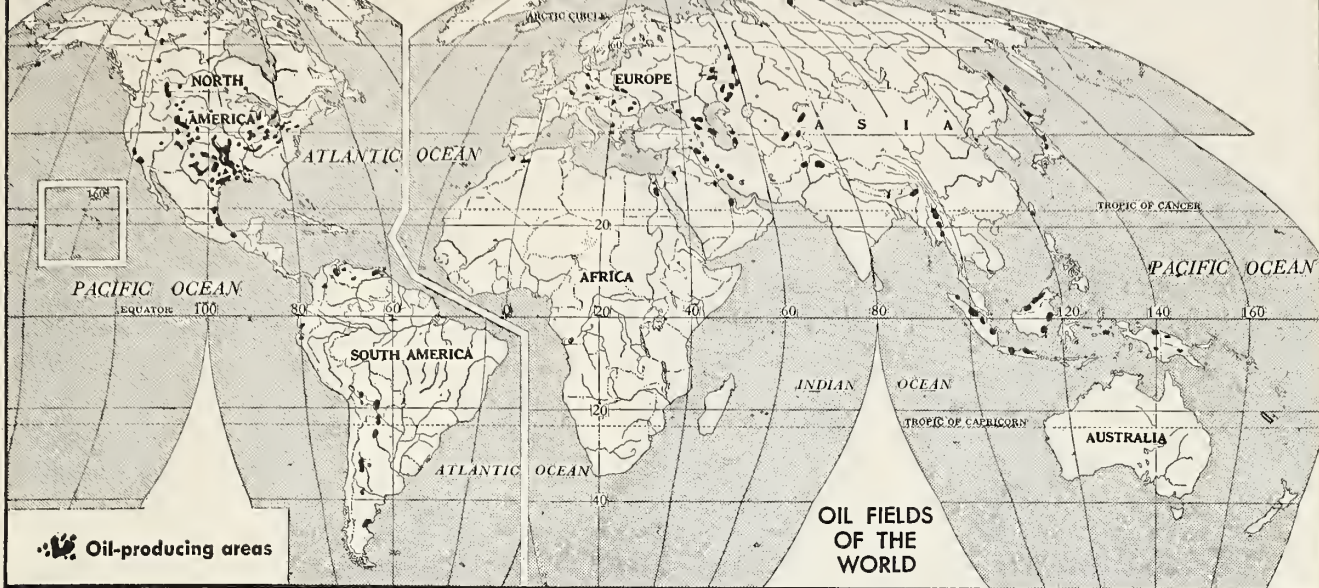
more about where such areas are. Oil can occur only in porous rocks. There it collects in pools only where the rocks are arranged in a way that traps the oil. On the whole, the most likely trap is an upward curve of the rock layers. The drawing shows how the arched rocks form an oil trap. Oil moves upward very slowly through the porous rocks. If they extend all the way to the surface, the oil escapes. If there is a layer of rock that is not porous above it, the oil is stopped; but if the solid layer is level, the oil is too widely spread out through the rock to be pumped out of a well. Where the rocks are arched upward, the oil collects in the top of the arch, perhaps with gas above and water below.

In modern oil prospecting, the first step is usually to take air views of a region. When these air views have been pieced together, they may show signs of the right kind of rock formation. If they do, geologists go out and spend a long time studying the rocks with great care.

Sometimes nothing can be seen from the surface. This is true in regions where a deep layer of earth covers the rock. Then prospectors use scientific instruments. In one method they drill a hole in the ground and set off charges of explosives in it. The explosions cause vibrations that go far into the earth and are reflected back from the rock layers. Delicate instruments record these vibrations. From them, trained scientists can tell not only the difference between rock layers but also how deep the layers are.

No known method yet tells whether there actually is oil in the earth at a given spot. The prospectors can tell only that the rocks are the right kind and in the right position. Only a wildcat well tells whether there really is oil. When oil has been found in one well, the scientists try to find out the size and shape of the oil pool.

The world's oil. The map on the next page shows where the world gets its oil. It does not show all the places where there



Location of the world's oil-producing fields.

might be oil, or even all the places where oil is known—just the places where there are oil wells producing oil.

No other area in the world has produced so much oil as the region around the Gulf of Mexico and the Caribbean Sea. In 1901 oil was discovered in southern Texas. Then, one after another, new fields were found. For a time the large series of fields extending from northern Texas across Oklahoma to Kansas produced more oil than any other area in the world. Another series of fields in West Texas reaches over into New Mexico.

In 1931 the East Texas field was discovered. This one is really in northeastern Texas. It became the most productive of all Texas oil fields. Ten years later geologists discovered that the same kind of rock extended eastward. The scientists traced it underground with their instruments, looking for a place where oil might again be trapped in the rock. They found such a place in the eastern part of Louisiana. Then they traced the rock eastward into Mississippi and found rich oil fields there.

At about the same time, fields along the Gulf coast of Texas were being extended eastward. Oil prospectors splashed through the marshes of southern Louisiana with their instruments. The next step in oil exploration

carried scientists out into the shallow waters of the Gulf. Now wells are drilled in water as much as ninety feet deep.

The oil region does not stop with the United States. There are important oil fields on the Gulf coast of Mexico. Far to the southeast, on the coast of Venezuela, there is a famous oil field. Here many of the wells are drilled into the bottom of the large bay that is called Lake Maracaibo.

While the Texas fields were being developed, oil was discovered in California, in the San Joaquin Valley and around Los Angeles. For a time California produced more oil than Texas. Many wells along the coast were drilled from platforms over the water. Others that are drilled on land reach out under the ocean. Instead of going straight down, they curve out under the water.

There are oil fields northward along the Rocky Mountains, as far into Canada as it pays to drill for oil. Canada has known deposits that are too far from industrial areas to be developed just yet.

Outside of North America the Soviet Union is the largest producer of oil. Most of its oil fields are located around the eastern end of the Black Sea and farther east, in Asia. There is also a great oil region in southwestern Asia, extending into Egypt.



N. Finikov from Sovfoto

The pumping machinery of an oil well. This one is in the Soviet Union.

Western Europe has been explored for oil, but only a few small fields have been discovered. As a result, western Europeans must import oil. The cost of transportation makes the price of the petroleum products high. Gasoline costs several times as much in western Europe as it does in the United States. In regions that are not industrialized, there has not been much exploring for oil. Where oil has been discovered in such regions, the people of the regions have not usually developed their own fields. European companies have developed oil fields in Indonesia, in southeastern Asia, and in southwestern Asia. American oil companies, too, have interests in some of these fields.

Conservation. There is enough oil in the earth to last for a long time, but much of it will be hard to get. Some of it is far

from industrial regions, making the transportation costly. Some of it is in rocks that must be mined, calling for much more costly processes than drilling oil wells and refining the liquid oil. Oil can be extracted from coal, but that, too, is a costly process. Certainly our present oil supplies should be used carefully and not wasted.

There are two basic ways to conserve oil. First, the producers should get as much as possible of the oil out of an oil field. Second, the users should get as much heat or power as possible from the oil.

In the early days of the oil industry millions and millions of gallons were wasted. When the drillers struck oil under pressure, a fountain of oil shot into the air. Often it carried the tools and derrick and, sometimes, the drillers along with it. Often it caught fire, and a great plume of flame and oily black smoke rose into the air for days. A spouting well was called a gusher. The oilmen usually let it spout for a while. Much oil was wasted, but the oilmen did not know how to handle such pressures. The pressure came from gas. When some of the gas had escaped, it was easier to put a cap on the well and turn the oil into a pipe.

Now oilmen try to save every ounce of that gas pressure. With better techniques they are able to get the well capped at once. The gas pressure will keep the oil flowing out of the well much longer before it must "go on the pump." But saving the cost of pumping is not the most important reason for keeping the gas in the earth as long as possible. Oil can be pumped from the well, but no pump can keep the oil flowing through the rocks toward the well. Only pressure inside the earth will do that. When there is no more pressure, the field is dead. There may still be much oil in the earth, but there is no known method of getting it out. Now oilmen let the gas escape as slowly as possible. They even pump back into the earth part of the gas that rises with the oil.

In earlier times, oil was wasted by drilling too many wells. Oil fields vary in size,

but most of them are not very large. The average is 500 acres—about the size of a large farm. Oil flows toward the wells. If one owner drilled a well, the next owner could not decide that his oil was like money in the bank and that he would save it to use later. His oil would all flow out of his neighbor's well. The only way he could get his share was to drill a well as soon as his neighbor did. This was a wasteful practice. Great quantities of oil cannot be stored and kept very long above ground, and much was wasted. Too many wells also lower pressure in the earth. Actually, too many wells decrease the total quantity of oil that can be recovered from the earth.

Now, partly by state laws and partly by the efforts of the oil companies, the development of a new field is carefully planned as a whole. Before it is developed, scientists study it carefully. Then they decide how closely the wells should be spaced to get all the oil without waste. The average is about one well to forty acres.

Another way to conserve oil is through more efficient use. The credit for this kind of saving goes to the men who have invented better machines, especially better engines. Some people say they have saved more oil than has been saved by better techniques in the oil fields.

Gas has often been mentioned along with oil. Most oil fields have gas. Some wells produce only gas. Gas is used for cooking and it is a most desirable fuel, because it burns with a hot flame and it is clean.

For a long time only cities near gas fields could have natural gas. Then longer and longer pipe lines were built to carry the gas to large cities. Now gas travels underground from Texas as far as New York.

New Techniques

Before you leave earth materials, there are a few other interesting techniques to note. Air and water are part of the earth, but in earlier times no one thought of using



R. I. Nesmith, Courtesy The Texas Company

Here an electric oil pump can be seen as a whole. The derrick has been removed.

them as a source of raw materials. Now they are being used. The air was used first.

Plants must have nitrogen in order to grow. The air is a mixture of gases. It contains more nitrogen than anything else, but plants cannot get their nitrogen from the air. They must get it from the earth. In many areas, farmers need to add nitrogen to the soil as a fertilizer.

In Chile in South America there are great deposits of a nitrogen compound that makes good fertilizer. For many years these deposits supplied most of the world with nitrogen. During World War I, German farmers were unable to get the Chilean nitrates. Nitrates are needed for explosives, too. German scientists worked out a process for getting nitrogen from the air. It is a difficult process, requiring the use of electricity. Before the end of the war, American scientists also had discovered how to do it. Now most of the nitrate that is used in the world is taken from the air.

The use of sea water as the source of any product except salt is more recent. Scientists learned that many materials besides

salt are dissolved in sea water. The proportion of most of them is so small that it does not now pay to extract them.

There is one exception. Magnesium has been known for a good many years. In very thin sheets or as a powder, it burns with a flash of brilliant white light. The crumpled metal in a photographer's flash bulb is magnesium. For a long time magnesium has been used in fireworks, for signal flares, and for taking flashlight pictures.

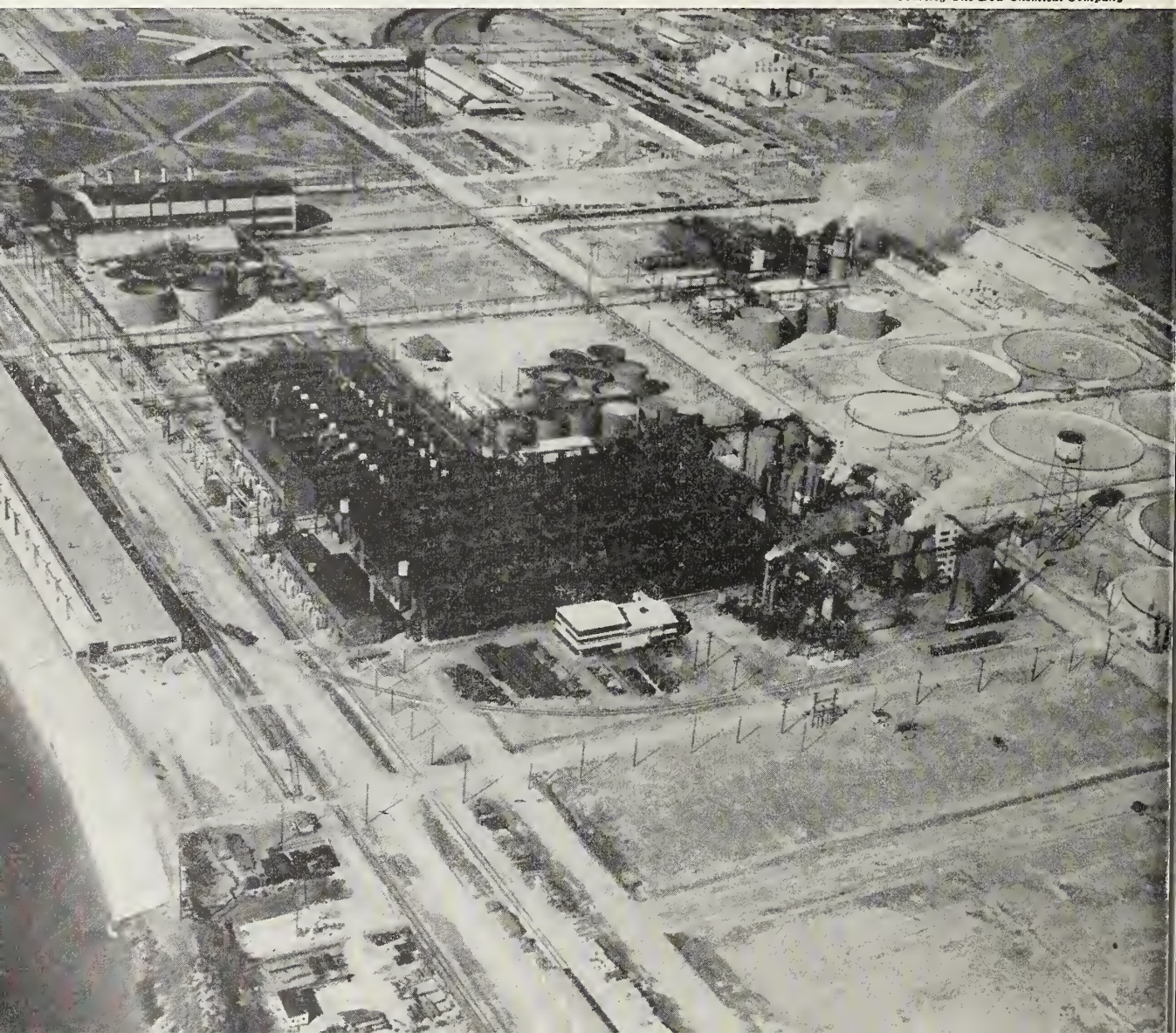
During World War II there was a great demand for light metals for airplanes and for

other uses. Aluminum is light, but magnesium is a third lighter than aluminum. Manufacturers began to experiment and found that an alloy of magnesium with a little aluminum, zinc, and manganese is very strong. Soon they worked out methods of handling this alloy and found many uses for it where lightness was needed.

There were mines of magnesium ore in the United States, but most of the metal was extracted by a chemical company from strong salt water pumped from the ground in Michigan. The supply evidently would not

This is a general view of the Texas plant that produces magnesium from sea water. It is on a narrow peninsula and has water on both sides, as you can see. The water is pumped in on one side, processed, and pumped out on the other side. With this system, the same water is not pumped in again.

Courtesy The Dow Chemical Company



be large enough as the demand increased. Why not get magnesium from a source that could never be used up—the ocean?

After long study of possible locations, the company chose Freeport, Texas, for the plant. There they are making large quantities of magnesium from sea water. There is another sea-water plant in England.

During the Middle Ages there was no science of chemistry. By processes which seem to us a mixture of bad science with magic, men called alchemists hoped to change more common metals into gold. Of course they failed. Then, slowly, the science of chemistry grew out of the knowledge gained by the alchemists. The chemists learned that all the thousands of different substances in the world are made up of compounds of less than a hundred simpler substances, which they called elements. Their studies led to the conclusion that one element could not be changed into another.

Toward the end of the nineteenth century, two new metals were discovered: uranium and radium. The ores of uranium and radium are dug from the earth just as other ores are. There are large deposits on the shores of Great Bear Lake in northern Canada. There are deposits in Colorado. The first deposits that were discovered and mined

are in Czechoslovakia. Some of the largest known deposits are in the mining region in the southern part of the Belgian Congo.

As scientists studied uranium and radium, they made a strange discovery. Uranium changes to radium. Radium changes through a series of elements and finally becomes lead. Some of the elements along the way last a long time. Some change so quickly that scientists were a long time discovering that they were there at all.

The changes from uranium to lead go on by themselves. Scientists cannot make lead from uranium in their laboratories. They cannot even make radium from uranium, but they can hurry up some of the earlier steps. The atomic bomb depended upon some of the techniques they worked out.

The elements that make up the earth are not quite so unchangeable as scientists used to think they were. Neither are they so changeable as the alchemists hoped. We cannot change the common and easy-to-get elements to the rarer ones. We cannot pull many of the elements from thin air. We cannot dip up a cup of sea water and pour elements out, although, with effort, we get magnesium from the ocean. Ordinarily, when we want to use earth materials, we must still mine them from the earth.

A WORKSHOP ON MINES AND MINERALS

When you were younger, you probably played with sand on a beach or in a sandbox or modeled in clay. Perhaps you have broken stones to see what they were like inside. If you are not already familiar with the common earth materials, you should get acquainted with them now. Learn how they look and feel and what you can do with them. The best way is by handling them and working with some of them yourself.

Your Community as a Laboratory

If you can visit a mine, you are very fortunate, but not many of the students who

read this book will be able to do that. Even if you live in a mining region, you will probably not be able to get permission to go into a mine. Many mines are dangerous. The owners and miners will not want you to run any risks. If you are fortunate enough to see materials taken from the earth, be sure to do as you are told. Miners themselves are careful, and you must be, too.

MINING COMMUNITIES

If you live in a mining community or an oil-producing region, this is the time to make an intensive study of your own community resources. Use your own plan, or

follow the outline below. This should be a coöperative project, with different pupils or groups doing different parts of the work.

Study of a Mining Community

I. The mineral resources

A. What the resources are

If the mineral deposit is the ore of a metal, learn the name of the ore as well as the name of the metal that is extracted from it. Get samples if possible.

B. Location of deposits

Perhaps a committee can make a map showing the location of the deposits and of mines or oil wells.

II. History of the industry

A. When and by whom the deposits were discovered

B. Beginnings of the industry

C. How the industry has affected the growth of your community

III. Techniques

A. Type of mines—shaft, open-pit, well, etc.

B. Machines and methods of work

C. Provisions for the safety of the workers

D. Conservation

E. Processing of the mineral after it is mined

IV. The workers

A. Number of workers

B. The jobs they do

You will find that the people who work for a mining company are not all miners.

EARTH MATERIALS IN USE

You could not possibly list all the uses of earth materials in your community. A very large part of our environment is made up of metal and products of clay, rock, and other materials from the earth. Each member of the class might make a list of twenty-five that he has seen in a small area or in a short time. You might list twenty-five things in your schoolroom, in your home, in a store, on the way to school, on a farm, or in a half an hour's walk. See who can make the most unusual list, with the largest number of items no one else has included.

COMMUNITY WORKERS

In every community there are workers whose jobs have something to do with minerals. You can find at least a few of them in your own community. There may be no miners, quarrymen, or oil workers, but perhaps there are offices of mining companies or oil companies. Your community may have a smelter or an oil refinery. If it has none of these, it may have factories that use minerals as raw materials. It surely has gasoline stations, coal dealers, and masons.

See how many you can find in your community. They will not call themselves mineral workers. Some work in factories. Some are in the building industries. Some buy and sell mineral products. Try to classify them according to the grouping in the occupation graphs on page 380.

ASK THE PEOPLE WHO KNOW

Even in a community that has no mineral resources, you can learn about mineral products by talking to people who work with them. Probably every member of your class knows someone whose work has to do with earth materials.

A coal dealer can tell you about different grades of coal and how each grade is used.

A gas-station owner or attendant can tell you about the gasoline and oil he sells.

A stonemason can give you samples of different kinds of stone and tell you how he cuts stone.

A bricklayer or mason or a building contractor can tell you about different kinds of brick and their uses, about building stone, and about other earth materials that may go into a building—plaster, mortar, roofing materials, asbestos insulation, etc.

A road builder can tell you about cement and concrete.

A farmer can tell you about fertilizers.

An electrician can tell you about insulating materials.

Anyone who uses tools can tell you how he keeps them sharp.

The owner of a hardware store can tell you about the uses of metals and many other earth materials. Most hardware stores have dishes, pottery, porcelain, glassware, paint, and polish, as well as metal articles.

Get into the habit of talking to workers about the work they do. The workers them-

selves can tell you far more than there is room to tell in this book.

Test Your Skill and Knowledge

This chapter has been about common, everyday things. Methods of getting the raw materials from the earth may have been strange to you, but not the products made from them. Everyone should learn to recognize the widely used metals and minerals and the common products made from clay.

You will have to make your own exercise to test your skill in recognizing earth materials. You need samples, not words or even pictures in a book. If each one of you brings a few samples from home, your group should have a good collection. Be sure you know the materials in your own samples. Then test the rest of the class on their ability to recognize the material in your sample.

Here are a few suggestions:

Rock

Samples of the building stones named in the text

Objects carved from stone (Tell the class what kind of stone was used if you can.)

Precious stones

Bricks and tile

Pottery of various kinds

Glass

Dishes (Use broken dishes. You can learn the difference between pottery and porcelain. Pottery is hard and glasslike all the way through.)

An asbestos mat

A piece of mica

Salt

Sulfur (Sulfur candles are sometimes used for disinfecting. If you should get one, do not light it.)

Metals

A copper penny (A penny is really bronze. There is a little tin in it.)

A piece of copper wire

A tin can

A lead sinker for a fishline

A galvanized iron pail or a piece of galvanized roofing (for zinc)

A brass knob or handle or a piece of a lamp (The same objects may be made of bronze. You should learn to tell the difference.)

A silver table knife with a stainless-steel blade

A knife, fork, or spoon of white metal (a nickel alloy)

An aluminum pan

A MINING MAP

The map at the beginning of this chapter, page 143, shows the principal mining areas of the world. Mining is used in its broadest sense, to include all methods of securing valuable minerals from the earth.

On an outline map of the world, copy the areas called for below. Write the name of each metal or other mineral suggested beside the corresponding area on your map.

1. Three oil regions on three continents.
2. Three iron-mining regions on either two continents or three continents.
3. Three regions in which several steel-alloy metals are mined, on two continents and an island.
4. Two tin-mining regions on two continents and a group of islands.
5. Three or more coal-mining regions on three continents.

A FEW EXPERIMENTS

WITH EARTH MATERIALS

There is no need for everyone in the class to perform all the following experiments. Assign special jobs to different members of the class, so that no one student will have to spend much time on the project.

1. Put a level tablespoonful of salt into a cup of water and stir until the salt disappears. Taste the water. Then boil the salt water in a pan until the water is gone. What is left in the pan?

2. You will need clay, sand, and ordinary earth. If you can, get the clay from a natural deposit, but be sure it is really clay. If you cannot get clay from the ground, use modeling clay.

From each of the three materials, try to shape a small bowl, toy size. You will probably have to dampen the materials in order to shape them. Let the bowls dry for a day or two in a warm place. Which bowl still holds its shape? People must have made the same kind of experiments long ago when they were learning to make pottery.

3. Lay an ordinary pin on something very hard, such as a hard, smooth stone or a piece of iron. Strike it with a hammer. Try the same experiment with a paper clip. What happened when you struck them?

4. For this experiment you need a small piece of iron, such as a nail. Leave it in a damp place for a few days. How does the iron change in appearance? When iron or ordinary steel is damp, oxygen combines with some of the iron. The reddish material, called rust, is the combination of iron and oxygen. It is a different kind of combination from the combination of salt and water in the first experiment. The most common iron ore is very much like rust.

When the experiments are finished, class members may work together in writing a brief report. Find places to use all the following terms: solution, evaporate, element, division of labor, chemical compound, dissolve, basic invention, malleable.

A GRAPH TO MAKE

From the graphs on pages 381, 383, 385, 389, 391, select the five countries with the highest percentage of miners. Add your own country if it is not included in the five.

Make a bar graph showing the percentage of miners in the working population of each country. Arrange the graph so that the longest bar is at the top and the others follow in order of length. Where does your own country fall?

No country, you see, has a very large percentage of miners. Can you classify the countries in any way, as densely populated or sparsely populated, industrial or non-industrial?

For additional comparisons, you can make a graph of your own. On page 350 are tables showing the workers, grouped by industries, in countries not included in the colored graphs. Notice that these tables give you the numbers of workers in each group, not the percentage. If you wish to use percentages, you can easily work them out. Perhaps someone will volunteer to work out percentages for the whole class to use.

HOW DO YOU USE THEM?

At the left side in the next column is a list of materials that are the source of something

you might use. At the right is a list of things you could do with products of the earth materials. You are to match the items in the two lists. For example, number 1 is "copper ore." At the right you find *c*, "You could buy a stick of gum with this." A penny is made of copper. You could buy a stick of gum with a penny. Therefore 1 and *c* match.

That starts you off with a score of ten. Now see how many more tens you can add.

- | | |
|---------------|--|
| 1. Copper ore | <i>a.</i> You could take a photograph with light from this. |
| 2. Sand | <i>b.</i> You often walk on this one. |
| 3. Bauxite | <i>c.</i> You could buy a stick of gum with this. |
| 4. Iron ore | <i>d.</i> You might use this to make plants grow better. |
| 5. Petroleum | <i>e.</i> This one stops electric currents. |
| 6. Sea water | <i>f.</i> Your kitchen probably has kettles and pans made from this. |
| 7. Clay | <i>g.</i> You eat off these. |
| 8. Limestone | <i>h.</i> This one takes you for an automobile ride. |
| 9. Mica | <i>i.</i> You could whittle with a product of this. |
| 10. Air | <i>j.</i> You see through this one and also drink out of it. |

ADDITIONAL INFORMATION

The United States Bureau of Mines and the Dominion Department of Mines in Canada have booklets on mineral resources and mining. They will be glad to send you helpful information if you ask.

Many companies have information booklets on their own products. Some are glad to send samples of the materials they use. You can find the names of companies in magazine advertisements.

Choose one member of your class or a committee to write for information. Be sure to explain that you are a school class, your grade, and what you are studying.



Power and Man's Work

WHAT DO WE MEAN BY POWER?

Have you used any power today? If you have turned on an electric light, or eaten toast made on an electric toaster, or listened to the radio, you have used electric power. If you rode to school in a bus, you have used power from fuel. If you have done nothing more than pick up this book, you have used the power of your own muscles.

Measurement of power. Power is the force that makes things move. That is not a definition. No one can define power. We do not know what it is, but only what it does. Even in measuring power, all we can measure is the work it does. We measure it in foot-pounds. A foot-pound is the power required to lift something that weighs one pound to a height of one foot. You can get the feel of a foot-pound of work by lifting something that weighs a pound.

You have probably heard people talk about horsepower, too. One horsepower is the power needed to lift 550 pounds one foot in one second. The measure was invented a long time ago when steam engines were new. People wanted to be able to compare the amount of work the new engines could do with the amount of work a horse could do. In fact, a horse cannot do that much work and keep it up. When you hear of an automobile with a 150-horsepower engine, it does not mean that 150 horses could really do as much work as the engine. It means that the engine can do 150×550 , or 82,500 foot-pounds of work in one second. That may seem like a clumsy way of measuring power, but we have no simpler way. We can measure power only by measuring the work it does. Whether it turns wheels or runs ships, we translate the work into weight lifting.

Power in your community. Perhaps you have never thought much about all this power that keeps things going. "Automobile" means "self moving"; but an automobile does not move itself. We might go one step farther and say that the engine moves it; but an engine is just a mass of carefully fitted pieces of metal. It cannot move by itself any more than the whole automobile can. We must look further for the power that moves the car. It is produced by burning gasoline. The machinery is there to direct the power so that it will make the wheels go round and to give the driver control of the car. But

the power comes from the gasoline, not from the machinery.

You may have to give yourself a little training in thinking about power. In our everyday speech we often cut corners. We talk about machines doing work, but the machine is merely a tool. Actually, power does the work.

Perhaps you will need to read a little farther before you begin to look for uses of power in your community. There will be suggestions in this chapter as you go along, and you will find many more suggestions in the Workshop beginning on page 203.

BEFORE INDUSTRY WAS MECHANIZED

The dark areas on the map on page 183 show the industrial regions of the world. In those regions great quantities of power are used to operate machinery. But power of some kind is used everywhere and always has been. A man of the Old Stone Age had no power but the power of his own muscles. He made his tools and used them with the strength of his own hands and arms. The use of additional power came with the New Stone Age.

First Experiments with Power

Right at the beginning of the New Stone Age, you remember, animals were domesticated. At first, maybe, they were just kept for food, wool, and hides; but before long someone discovered that animals could be trained to carry loads and drag things behind them. That discovery was probably made many times by different people.

Early in the New Stone Age those inventive people at the eastern end of the Mediterranean began using animals for plowing. They substituted for their own muscles the strong muscles of oxen and donkeys. For the first time they were making use of power that did not come from their own effort.

Another of the world's great basic inventions was made early in the Bronze Age—the wheel. A wheel does not produce power, but it makes more effective use of power. An animal can pull a much heavier load in a cart with wheels than he can drag over the ground. So can a person. That is an experiment you can try for yourself.

Nearly all primitive peoples we know about had boats or canoes of some kind. This was true in the distant past and it is true of the modern primitive peoples. At first these boats were propelled by men working with paddles on the small canoe-like boats and with oars on the large ones. Paddling and rowing are hard work. Someone has said that inventions are made because people are lazy and want to save themselves work. That is not always true, but in the case of boats, people did make an invention that saved much work. They invented sails.

The use of the wind for power to drive boats through the water is so old that we do not know when it began. There are pictures of boats with sails from the very earliest times in Egypt. Sailboats were probably used as early in other lands around the eastern Mediterranean. In China as well as in southeastern Asia, it seems that there were sailboats in very early times.

Power for Grinding Grain

One of the hardest and most monotonous tasks of ancient times was grinding grain. A great deal of grain had to be ground because everyone ate bread at every meal.

Grinding by hand. There are several primitive methods of making meal from grain. Around the eastern end of the Mediterranean, the grain was rubbed between two stones. There are little statues from Egypt that show how the work was done. A long, flat stone rested on the floor. The worker knelt at one end and placed a little grain on the stone. Then she rubbed a smaller stone back and forth on the grain until it was broken up into meal. The Mexican metate, which you saw in the picture on page 57, is the same kind of implement. Animal power could not be used for this grinding technique. Hands were required to push the stone back and forth.

Fairly late in ancient times, a new kind of mill, called a quern, was invented. Two round stones were used. The lower stone was hollowed slightly. The upper stone was

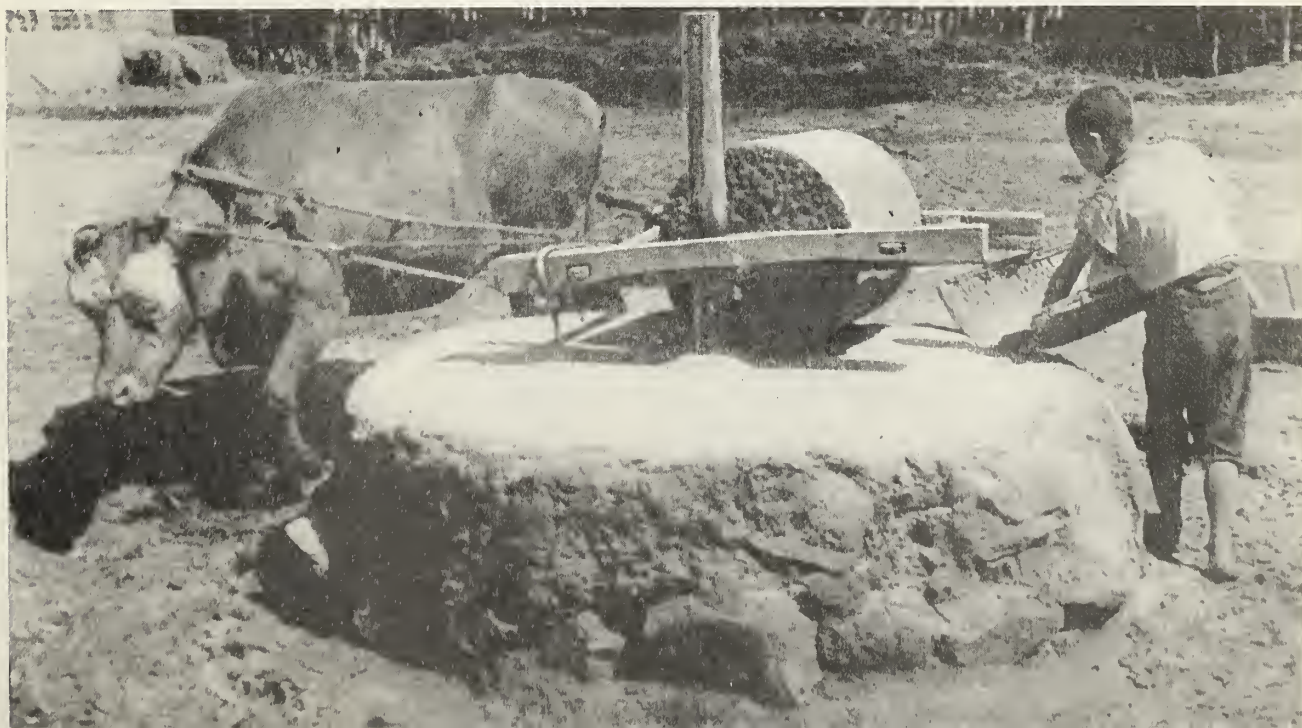
rounded to fit into the hollow. Usually a hole was bored near the edge of the upper stone and a wooden handle was driven into the hole. The stone was turned round and round to grind the grain. A hand quern cannot be large, for a round-and-round motion of the arm cannot keep a very heavy stone going. Nevertheless, the quern was a better grinding implement than the metate.

In the New Stone Age and early Bronze Age every woman was a miller. Grinding grain was the first step in baking a day's supply of bread. Later, milling became a specialized occupation in some places. Then the querns turned by hand-and-arm power were too slow. Larger mills were needed. They were still made like the small querns, but they needed more power. Instead of a mere handle, a beam was attached to the quern, extending out to one side. If the quern was set up at a comfortable height, a man could walk around it, pushing the beam to turn the upper stone.

Donkey power. From a man-power mill the next step was an animal-power mill. Donkeys were the animals most often used,

A Manchurian farmer uses animal power to crush grain. The olive crusher described on page 71 is much like this primitive machine. So are the sugar-cane crushers used in many places.

Seifoto



though the Romans sometimes used horses. A donkey or a horse was hitched to the beam of the mill. All day he walked round and round in a circle, turning the mill.

Rotary (round-and-round) motion produced by animal power has not gone out of use. In many places in the world you could see oxen, donkeys, horses, or camels turning mills, olive presses, sugar-cane presses, and wheels with buckets around the edge to lift water from wells or irrigation ditches.

Water wheels. The next basic invention in the use of power was a simple water wheel. People must always have known about the force of a running stream, but this source of power was not put to work until about 100 B.C. The first water wheel seems to have been invented in Greece. It was not a wheel at all, as we think of a wheel. Imagine an ordinary wheel—not an automobile wheel, but a wheel with spokes. Then imagine the rim taken off and boards several inches wide put in in place of the spokes.

The wheel was laid down flat in the bed of a small, swift stream, usually with the hub

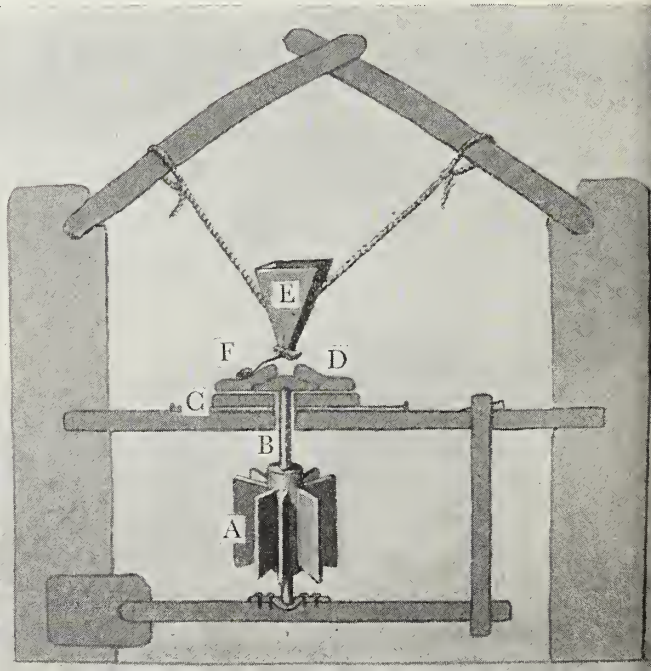
resting on a stone. A strong wooden beam, which we should call a shaft, took the place of the axle. The wheel was fastened tightly to the shaft, so that, when it turned, the shaft had to turn with it.

The shaft extended up through a hole in the floor of a building above it. The lower millstone lay on the floor. The shaft ran through a hole in the lower millstone, but was fastened tightly to the upper millstone. When the wheel in the stream bed turned, the shaft turned. When the shaft turned, the upper millstone turned.

The Greek wheel was a very simple machine, but it worked. It worked so well that it was used for two thousand years. During the Middle Ages it was the commonest type of water wheel over most of Europe.

Although in some places the Greek wheel was used down to modern times, another kind of wheel is almost as old. It is a Roman invention. The inventor set the water wheel up on edge, so that the blades on the lower side dipped a little way into the water. The shaft was now horizontal, and there was no use in fastening a millstone to

A mill with a wheel of the Greek type. The picture shows how the mill looked, and the diagram shows how it worked. *A* is the water wheel. *B* is the shaft between the water wheel and the upper millstone. *C* is the lower millstone and *D* the upper millstone. Grain was poured into the hopper, *E*, above the stones. *F* is a pebble attached to the hopper by a string. As the upper millstone turned, its rough upper surface moved the pebble in jerks and bounces, jiggling the mouth of the hopper enough to shake out the grain. In the picture the stream bed is dry. Water can be turned into it when needed to operate the mill.



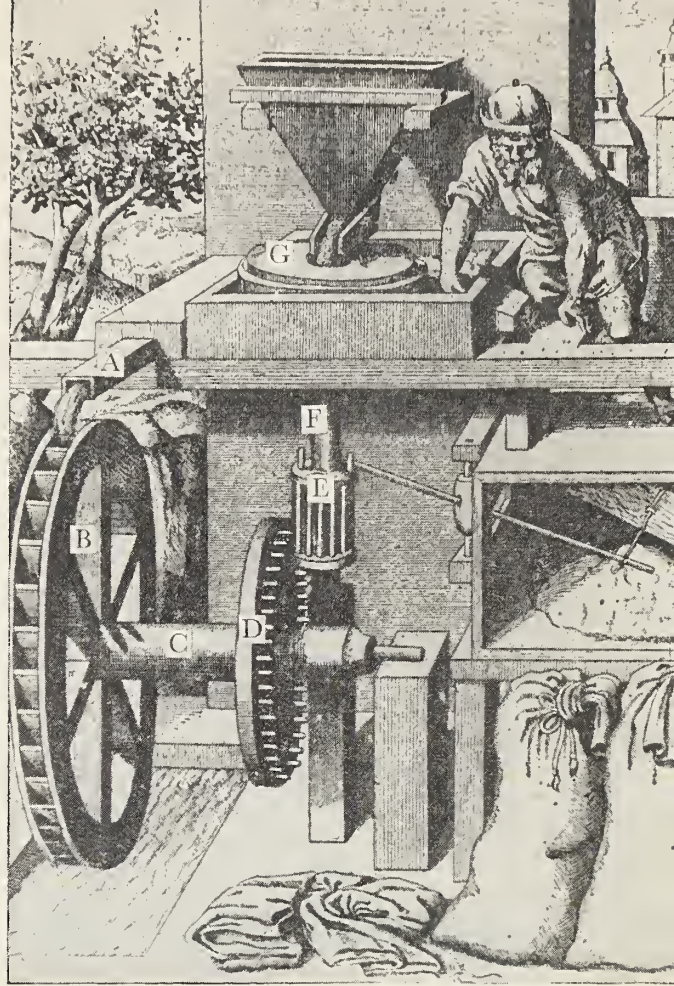
the other end of it. The inventor had to make power turn a corner.

Gear wheels solved the problem. The picture at the right shows how the gears worked. This drawing was made during the Middle Ages. There had been a few changes since Roman times, but the principles are the same. The Romans used a small gear wheel with pegs instead of the pinion, *E*. In the pinion the pegs are longer and fastened at both ends to give them more strength.

The gear wheel, *D*, was on the shaft from the water wheel and turned with it. As the gear wheel turned, one of the pegs on the edge caught a peg of the pinion and gave it a little push. The pinion had to turn an inch or so. Its shaft, *F*, and the millstone above had to turn, too. Then the pegs slipped apart, but by that time the next pair had caught and the pinion got another push. As one pair of pegs after another caught, the millstone was turned round and round.

Another type of water wheel was invented a little later. The original Roman wheel was an undershot wheel. Swiftly flowing water struck the blades on the lower side of the wheel. The new type was an overshot wheel. Instead of flat blades, the wheel was equipped with little troughs called buckets. Water was brought in a trough to the top of the wheel. There it poured out into the buckets, and the weight of the water turned the wheel. Both kinds of wheels were used all through the Middle Ages and down to modern times. In fact, some of them are still in use, even in mechanized America.

Windmills. You have seen how the wind was used in ancient times to drive ships by means of sails. A new way of using wind power was invented early in the twelfth century. The invention was a windmill. Inventors were still working on that problem of grinding grain for bread, you see. Not every village had a stream that could be used to turn a water wheel, but in every village the



The Bettman Archives

A medieval miller at work. You can understand the machinery by following the letters in the picture. *A* is the flume, bringing a stream of water to *B*, an overshot water wheel. The shaft, *C*, and the gear wheel, *D*, turn with the water wheel. By the Middle Ages a pinion, *E*, was used instead of a second gear wheel. One turn of the wheel, *D*, makes the pinion turn several times. With it turns its own shaft, *F*, and the upper millstone, *G*. Above the millstone is a hopper for the grain.

winds blew at times. With the windmill the wind could be put to work.

A windmill, again, is a rimless wheel with light wooden wings as spokes. The wings are called vanes. The vanes are set at a slant, so that when the wind blows against them, its force turns them round. You probably know how to make paper windmills. The vanes of a windmill are not the same shape, but the principle is the same. The grinding stones inside the old windmills were like the millstones of the water mills. Windmills were also used for pumping water.

POWER IN THE MECHANIZATION OF INDUSTRY

Throughout the Middle Ages, people were satisfied with power from animals, water wheels, and windmills. As industry increased, however, they had one task that could not be performed with power from these sources. They needed a pump to get water out of mines, and their need for a pump led to the invention of a steam engine.

Power from Steam

The first steam engine that worked was built in 1711 to pump water from an English coal mine. The inventor's name was Newcomen. His engine operated on a different principle from modern engines.

Steam engines. James Watt, a Scotsman, is credited with the invention of the modern engine, though he used some ideas from Newcomen's engine. Watt worked during the second half of the eighteenth century. At first Watt was interested in making a better engine for pumping water from mines.

This is one of Watt's later steam engines. It works like the one described at the right, except that the connection with the wheel is different. *A*, at the left, is the cylinder. You cannot see the piston because it is inside the cylinder. *B* is the connecting rod, and *C* is the seesaw beam. *D* is the connecting rod at the other end of the beam. It turns the wheel and produces rotary motion.

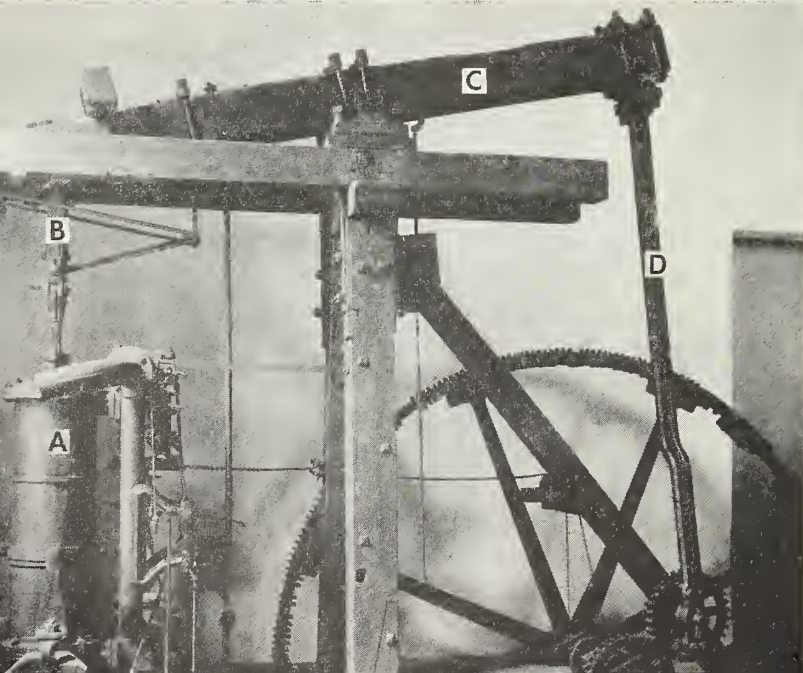
The engine he invented was a hollow cylinder, standing upright, with a piston inside. From a boiler, steam was let into the cylinder below the piston to push it up, and then above the piston to push it down. A rod connected the piston with a beam above it. The beam was mounted on a support so that it could rock up and down like a seesaw. The end away from the engine was attached to a pump. As the steam pushed the piston up and down, the beam rocked up and down like a pump handle.

Watt was also working on the problem of changing the up-and-down motion of the pump into rotary motion. The method he used seems very simple, now that we are familiar with it. He kept the crossbeam, which was worked up and down by the engine. At the other end he attached a connecting rod, fastened by means of a joint so it could swing back and forth. At its lower end the connecting rod was attached to the spoke of a wheel. As the beam pushed the connecting rod, it could move down only by turning the wheel. Then as the beam pulled the connecting rod upward, it continued the turn.

It is hard to understand machinery without seeing it. There is one place where you can see how the back-and-forth motion of a steam engine is turned into rotary motion. The next time you see a steam locomotive, look for the cylinders and drive wheels. The cylinders are not upright, as in Watt's engine. They lie on their sides. Pistons move back and forth. You cannot see the piston because it is inside the cylinder, but you can see the connecting rod turning the wheel.

The first factories. At the time Watt was working on steam engines, other inventors were

Philip Gendreau



working on machines. You have probably read about the Industrial Revolution, which began in the middle of the eighteenth century. It began in England with machines for spinning thread and weaving cloth.

The first factories were not run by steam power. They began before Watt had succeeded in getting rotary motion from an engine. The first rotary engines were built in the 1780's. A few cotton and woolen mills were built for steam power soon after; but water power was much more common for many years. Steam engines were expensive, and they required coal. A water wheel cost much less, and it needed no fuel.

During the early nineteenth century, steam engines were improved and were used more and more. A factory powered by a steam engine could be built anywhere. Even along the streams, in the older textile regions, manufacturers wanted more power. Steam engines replaced water power almost entirely, except for the little village gristmills and sawmills scattered over the country.

Steamships and locomotives. A revolution in transportation was another result of the invention of the steam engine. After many attempts, successful steamboats were built early in the nineteenth century. In the 1820's a number of inventors were working out methods of making steam vehicles run on rails. The first ones built did not have enough power to be useful. George Stephenson, an Englishman, made the improvement that started steam railroads on their way. He designed a better boiler and he used a forced draft. You probably know that a fire must have a draft. Air must pass through the fire or it will not burn. Stephenson turned the used steam from the cylinders into the smokestack. The steam still had enough force to draw more air through the fire.

Problems in the use of power. With steam engines running machines, driving ships, and pulling railway trains, we see another new culture coming into the world.

It was as definitely a new culture as the Bronze Age culture that followed the culture of the New Stone Age.

Some people have called the new period the Machine Age. Perhaps a better name for it is the Age of Power. When we talked about mechanization in farming, forestry, mining, and manufacturing, we were talking about power machines. We were talking about machines that multiply many times the amount of work a man can do.

It is said that one pound of coal equals a man's work for a day. That statement calls for explanation. It means that a pound of coal, properly used, can produce as much energy as a man can produce in a day's work. Sometimes the words energy and power are used as if they meant the same thing, but energy really means more than power. Light, heat, and electricity are all forms of energy. Heat can be made to produce power, as when coal is burned under a boiler to make steam for a steam engine.

All the energy that could possibly be produced from a pound of coal is called its *potential energy*. No engine has ever been invented that uses all the potential energy in coal. Even the best modern engines waste more than they use. Much energy is wasted as heat. If you have ever stood close to a steam locomotive, you know that it is hot. That heat is wasted. It is going off into the air, not heating steam to make power. Power is wasted by friction, too. Friction is the drag of one material rubbing against another. If you slide a book across a table, you can feel the pull of friction.

Lost heat and friction are two reasons why engines waste part of the energy in fuel. Engine builders have been working for more than two hundred years to overcome the difficulties and design engines that will turn more of the fuel energy into power. The efficiency of an engine is measured by how well it uses the potential energy in the fuel. If an engine turns 20 percent of the potential energy into power, it is said to be 20 percent efficient. Even with all the

improvements the average engine efficiency in the United States in 1941 was less than 20 percent. Even so, this was much better than the efficiency of early engines.

As an average for the whole United States, the work that was done by ten pounds of coal in 1882 could be done by 1.55 pounds in 1941. In the textile industries in 1815, it

was necessary to use fifteen pounds of coal every hour for each horsepower an engine produced. At the present time less than two pounds is needed. Inventors, you see, are perhaps the greatest conservationists. When they can make two pounds of coal do the work formerly done by fifteen, they have saved thirteen pounds of coal.

NEW MACHINES AND NEW TECHNIQUES

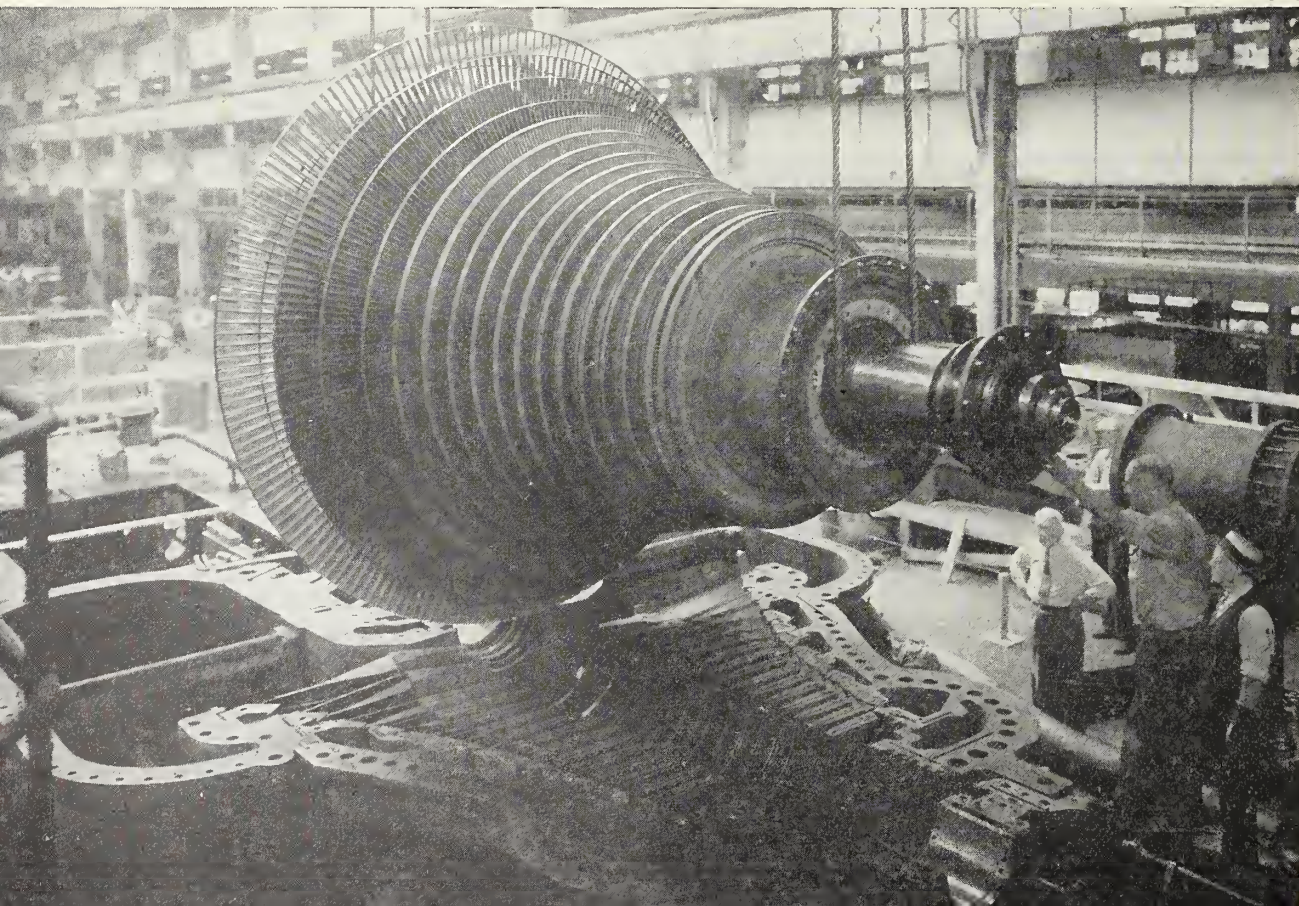
You have just read about how steam engines were made more efficient. You do not need to understand all the improvements that have been made. Some have been in metalworking. Parts are shaped to fit much more closely than in early engines. New alloys that will stand greater heat and pressure have helped. Lighter and less clumsy engine design has helped. Better methods of putting the power to work have helped,

too. For example, you do not see engines any more with the great seesaw beam rocking back and forth. Modern engines make the wheels go round with less waste motion.

In the 1880's an entirely new type of steam engine was invented. This was the steam turbine. The picture on this page shows how a turbine looks. It is essentially a great many small curved blades set around a shaft. The whole assembly of

A new steam turbine is assembled. The hundreds of thin blades are made of chrome steel. This shining white metal is used, not for its beauty, but for its high resistance to damage from heat and pressure.

Courtesy General Electric Company



shaft and blades is called the rotor, because it is the part that turns. In the picture a huge rotor is being lowered into the bottom half of its covering. When the top is on, the rotor will be entirely enclosed. Steam under high pressure enters the turbine at the smaller end. It presses against the many curved blades and forces the rotor to turn.

Steam turbines are simpler than steam engines with pistons. They run more smoothly. Power engineers do not consider them better for all purposes, but they are used to turn the generators in a great many electric power plants. In very recent years a number of railway locomotives have been built with turbines instead of cylinder engines.

Power from Petroleum

We cannot entirely separate one source of power from another. The story of the steam engine has been mainly the story of coal; but fuel oil from petroleum has taken the place of coal on many steamships and trains. Its great advantage is ease in handling. It can simply be poured into the tanks of a ship or locomotive, and it flows through pipes to the burners under the boiler.

New engines for new fuels. Although petroleum fuels are used to fire many steam engines, their greatest use is in internal-combustion engines. Those long words simply mean that the fuel is burned inside the engine. People seem to have liked big words when the internal-combustion engine was invented and named.

Inventors worked on the idea for a long time before they had petroleum products to use for fuel. In the late 1600's a Frenchman made a model engine to be worked by exploding gunpowder. As you can probably guess, it was never used for power. Almost two hundred years of invention and experiment were needed before there was a really useful internal-combustion engine. The first fuel was gas. Gas and air were forced into a cylinder and lighted by an electric spark.

The mixture burns so fast that the burning is often called an explosion. Burning gases expand. The expanding gases forced a piston to the other end of the cylinder.

Since this basic invention, many improvements have been made. A modern internal-combustion engine looks very different, but the principle remains the same.

Now we must go back to two other lines of experiment and invention that were going on at the same time. Do you remember about the first American oil well, drilled in 1859? From that time on, scientists were busy trying to make petroleum useful. At first, the product people wanted was kerosene for lamps. It was impossible to get kerosene from petroleum without producing gasoline, too. Oilmen hoped a job might be found for gasoline, but in the meantime it was a nuisance.

Engines for automobiles. Now for our third group of inventors. They were working on the idea of a horseless carriage. Wagons run by steam engines had been made even before the railway locomotive, but they were not successful. Their inventors were too far ahead of their time. Much, much more had to be discovered about engines, machines, and metalworking. In other words, the whole level of *technology* had to be raised. You know the word technique. Now think of all the techniques of a given time—1800, for example. When you do that, you are thinking of the technology of 1800. We can say that, in 1800, the technology was not good enough to produce a useful automobile. Techniques of metalworking were not good enough. Machines were heavy and clumsy and slow. Engines were not good enough. Techniques of applying power to machines so that it would do work were not good enough.

When railroads were in successful operation, inventors seemed to forget power-driven road vehicles for a time. Toward the end of the nineteenth century, however, inventors again were hard at work, trying to make an automobile. We might say that the three

lines of invention and experiment came together about 1890. Oil scientists and engine makers had found that gasoline was an ideal fuel for internal-combustion engines. Other inventors found that the internal-combustion engine was best to drive an automobile. The year 1892 is the date generally given for the invention of the automobile. In that year Charles E. Duryea built the first really successful automobile using gasoline as fuel.

If you ever have a chance, look through old magazines published from 1895 to 1905. Be sure to read the jokes. You will have many good laughs—but you will be laughing at the authors and not at the jokes they made. To shout, “Get a horse!” at someone in an automobile was supposed to be hilariously funny. Roads were poor and automobiles did not have much power. A picture of an automobile stuck in a mudhole was very funny. Even funnier was a picture of the motorist getting a farmer with a team of horses to pull the automobile out of the mudhole. A man pushing an automobile uphill was also considered very funny.

When we think of internal-combustion engines, we usually think of automobiles, busses, and trucks. Automobiles were first. Early engines were not powerful enough for busses and trucks, and so the heavier vehicles

did not come into common use until about twenty years after the automobile.

The mechanization of farm machinery soon followed. It may surprise you to learn that some of the earlier farm machines were powered by steam engines. Now nearly all of them are operated by internal-combustion engines. Tractors pull farm machines and furnish power for sawing wood, threshing grain, baling hay, chopping silage, and grinding feed.

The tasks of internal-combustion engines are increasing all the time. Road scrapers, rollers, bulldozers, lawn mowers, motorcycles, motorized bicycles and scooters, many loading and lifting machines, boats, and even many large ships and trains are run by internal-combustion engines.

Machines powered by petroleum are not all run by gasoline engines. In 1897 a new kind of internal-combustion engine was invented in France. It was named the Diesel engine after its inventor. Diesel engines are simpler and more powerful than gasoline engines, but they did not come into general use for a long while. They, too, were ahead of the technology of their time. Pressure in the cylinders was so great that the engines had to be too heavy for vehicles. Large Diesels were used to supply power for

Diesel switch locomotives like this are more powerful and start more quickly than steam locomotives.

Courtesy Baldwin Locomotive Works



factories, especially in Europe. One of the largest Diesel manufacturing plants in the world is in Denmark.

When strong, tough alloy steels had been invented, Diesel engines could be made lighter. Less metal was needed to withstand the high pressure. Better engine design and better fuels also widened the use of Diesels. Petroleum refineries now produce special Diesel fuels that have no other use.

During the 1930's and 1940's the use of Diesel engines increased rapidly. They were built into trucks, busses, and tractors. In power shovels and mining equipment they began to replace other sources of power. For such purposes Diesel power is still used in only a small percentage of the machines. Most of them are run by electricity.

If you train yourself to listen, you can recognize a Diesel engine by its sound. The big ones make a loud, sputtering hum. If you want to hear them at their noisiest, listen beside a railroad track. Most of the shining, streamlined trains that go streaking across the country have Diesel engines, and nearly all the switch locomotives are Diesel powered. Ship Diesels are even larger, but you are not so likely to be able to listen to a ship's engines.

Power for planes. An airplane engine is basically the same as an automobile engine. It is a gasoline-powered internal-combustion engine. Like the automobile engine, it is made up of a number of cylinders. Each of these cylinders could really be called an engine by itself.

An airplane engine must be more powerful than an automobile engine. Lightness is important, and so the airplane engine must be made as far as possible of lighter metals. To develop its great power, it must be made with the most exact workmanship. Airplane engines require better gasoline than automobile engines, too. Study of airplane fuels during World War II resulted in amazing improvements in gasoline.

With all its lightness and power, and even though the cylinders are arranged differently,

an airplane engine is still essentially an automobile engine. An ordinary engine for an airplane, that is. Jet engines are something quite different.

Would you like to do an experiment in jet propulsion? You need an ordinary rubber balloon that you blow up with your breath. Blow it up tightly. Then, holding the opening shut with your fingers, raise the blown-up balloon as high as you can and let go. Don't toss it. Just let go. The air compressed in the balloon makes it shoot through the air just as compressed gases in a jet engine make the airplane shoot through the air. The plane does not need a propeller.

One type of jet engine is more or less egg-shaped inside. Air is drawn in at the front and compressed. The fuel is kerosene. It is sprayed into the engine and burned. The hot air and gases from the fuel expand. Under great pressure they shoot out through an opening at the back, just as the air shoots out of your balloon. There is a small turbine in the opening, which the gases turn on the way out. The turbine works the machinery for compressing the air.

Electricity as Power

Electricity comes into your home on a wire. You cannot see it and it makes no sound, but the current from that same wire will light your home, cook your food, freeze ice cubes in the refrigerator, heat your room or cool it with a fan or ventilator, run the vacuum cleaner and washing machine, pump water, and operate machinery of almost any kind you like. We do not know what electricity is, except that it is a form of energy. But energy is defined as the capacity for doing work. When we say that electricity is a form of energy, we have said only that it can do work.

By 1946, there were 36,000,000 homes in the United States wired for electricity. This was more than 90 percent of all homes. If you live in the United States, there are nine chances out of ten that you have electricity

in your home. But in 1930 there would have been only about seven chances out of ten. Practically all city homes have had electricity for a long time, but electricity for country homes is more recent. For example, 2,351,045 farms had electricity in 1940. Five years later 5,950,000 farms had it.

Discoverers and inventors. The ancient Greeks learned that amber rubbed with a cloth attracts light objects, such as leaves and straws. Little more was discovered about the mysterious force until the time of Queen Elizabeth. The Queen's physician carried on experiments and, in 1600, wrote six books explaining what he had learned. He named the mysterious force electricity from the Greek word for amber.

In the early 1700's an English scientist discovered that electricity would travel through metal and some other materials, but not through all materials. In other words, he discovered that there are conductors and nonconductors of electricity. If there were no nonconductors, we could not use electricity because we could not control it. Among our best nonconductors—we call them insulating materials—are rubber, glass, clay products, and mica.

In 1796 an Italian scientist made the first electric battery. He discovered that plates of two kinds of metals, stacked up alternately and surrounded by chemical solutions, give off an electric current. In 1820 a Danish scientist was lecturing on electricity, using a battery. He happened to move a compass under a wire from the battery. The compass needle swung around as it passed under the wire. His discovery, that electricity attracts metal as a magnet does, was one of the most important in the development of knowledge about electricity.

Soon an English scientist, Faraday, discovered that if a magnet is moved through a coil of wire, an electric current is set up in the wire. Using the principle he had discovered, he built the first generator. On a shaft he mounted a disk of copper in such a

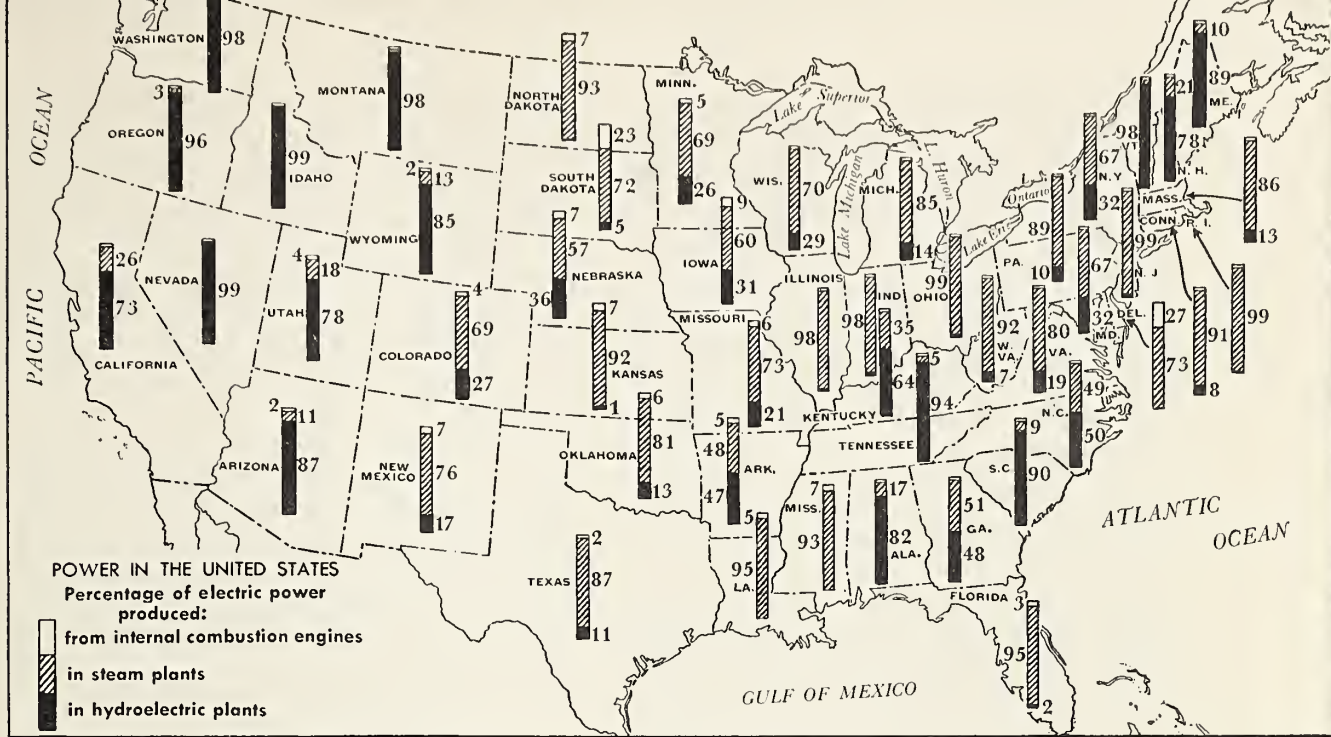
way that it could be turned between the arms of a horseshoe magnet. A wire was attached to the shaft and another arranged so that the edge of the turning disk brushed against it. A current of electricity was produced in the wires. Our modern generators are not made of copper disks and horseshoe magnets. They are far larger and more complicated than that first generator, but they work on the same basic principle.

The first real use of electricity was for sending messages. The first telegraph line was built in 1843, between Washington and Baltimore. The inventor of the telegraph was Samuel F. B. Morse, an American. In 1875 another American, Alexander Graham Bell, invented the telephone. In both the telegraph and the telephone electric currents carry the messages.

Lighting was the next job of electricity. The first arc lamps were used to light streets in San Francisco in 1879. French, English, and American scientists all contributed to the invention. In an arc lamp an electric discharge, called an arc, jumps across a space of two or three inches between two sticks of carbon. The arc gives off a bright light.

In the meantime, other inventors had been working on lamps that were based on an entirely different principle. If an electric current is passed through a conductor that is really too small to carry it, the conductor becomes hot. If it can be made hot enough, it glows with a bright light. The principle had been known for a long time, and inventors in many countries had been trying to use it to make a lamp. An American, Thomas A. Edison, succeeded in 1879.

The early experimenters with electricity did not think of using it to turn machines. Then, in 1873, a Belgian scientist built two generators of a new kind. He intended to show them at a fair in Vienna and had set them up side by side to test them. One was connected with an engine and was running. The other had not yet been connected with its engine. While the inventor watched, a workman made a mistake. He picked up a



wire from the generator that was running and attached it to the other one. At once the second generator began to turn. The inventor saw the possibilities revealed by the workman's mistake. If an electric current from one generator would travel along a wire and make another generator run, it could be used for power. The second generator could be made to turn machinery. Electric motors of today are not quite the same as generators, but they use the principles discovered in 1873.

Sources of power. More than 60 percent of the electricity used in the United States is produced by steam engines. Nearly all the rest is generated by water power. Only about one percent is produced by internal-combustion engines.

The machinery for producing electricity is usually called a power plant. In a steam power plant the essential machinery is a steam engine and an electric generator. Most modern plants have steam turbines. Coal, oil, or gas is burned to heat the water in the boiler. The engine turns the generator that produces electricity.

power is not enough. You cannot see all the electric motors running machines, pumping water, pulling subway and railroad trains, but you can see the lights. All the land beneath you is a blaze of light. You can follow the rivers and coast line because the water is black except where a row of lights means a bridge. As you leave the city behind, long strings of light mark highways. In the distance, clusters of lights show the location of smaller cities and towns. The same thing is true in every densely populated region. The picture on pages 12-13 shows you how a great city looks at night.

Water power in the eastern United States. Compare the map on page 195 with physical-political United States on pages 378-379. You will see that the states pro-

ducing the highest percentage of hydro-electric power are in mountainous regions—the southern Appalachians, northern New England, and mountainous states in the West.

In northern New England the power comes from many small dams and power plants. These plants furnish most of the electricity used in the region, but the total quantity is small. Population is sparse, and there are not many industries.

Now look at the southern Appalachian region. Compare it with the United States population map on pages 374-375. You have read about the industrial region in western North Carolina and South Carolina. This, too, is a region of comparatively small dams. Both the urban and rural population is much denser than the population of northern New England, however.

If you remember what you have read in your earlier study of geography, you know that this is a region of cotton mills, furniture factories, tobacco factories, and paper mills. It is one of the outstanding manufacturing areas of the new industrial South, and it is a good example of what hydro-electric power can do for a region.

The high percentage of hydro-electric power in Tennessee and Alabama is due to the development of the Tennessee Valley. Early in the 1930's, the United States government set up an organization named the Tennessee Valley Authority, usually called TVA. The purpose was not just to help one region, but to show what could be done when careful plans were made for a whole river valley. The Tennessee was chosen because the people of the valley were especially in need of help. The valley was largely a region of poor farmers. Erosion was ruining their land. Floods washed away their crops and their houses.



Transportation was poor. There were few industries, and, therefore, there was little choice of occupation.

Hydroelectric power was not the only purpose of the TVA. Another purpose was flood control. Look at the map on page 196 and notice how many dams there are on the tributaries of the Tennessee. Those dams hold back the water after the heavy rains of winter and spring. They let it flow down into the main river a little at a time. It does not come down in a rush and flood the main valley. The dams also deepen the water so that the river is more useful for transportation.

You have not had anything quite like the picture map. It is a combination of map and diagram. The rivers do not look exactly as they would on a real map. The drawing was made to show how the dams hold back the water of the rivers.

The power stations are connected by a network of power lines. The network supplies many cities with light and power. It operates great fertilizer factories and aluminum plants. These industries require power in huge quantities.

Water power in the West. In the West, also, large dams have been built by the United States government. No one river has been so fully developed as the Tennessee, but plans have been made for the full use of the Columbia. Three large dams have already been built on the river. Grand Coulee Dam is the largest in the world. The first power was produced there in the spring of 1941, a few months before the United States entered World War II. The dam was planned to supply water for the world's greatest irrigation project, the Columbia Basin project—south of the dam and partly enclosed in the great bend of the Columbia. The plans call for irrigation of a million acres.

Even the great Grand Coulee Dam cannot raise the river level high enough so that water will flow into the Columbia Basin. It will have to be pumped. Power from the hydroelectric plant will pump the water into the

basin. Irrigation pumps and light and power for the people who live on the land will have first claim to the electricity.

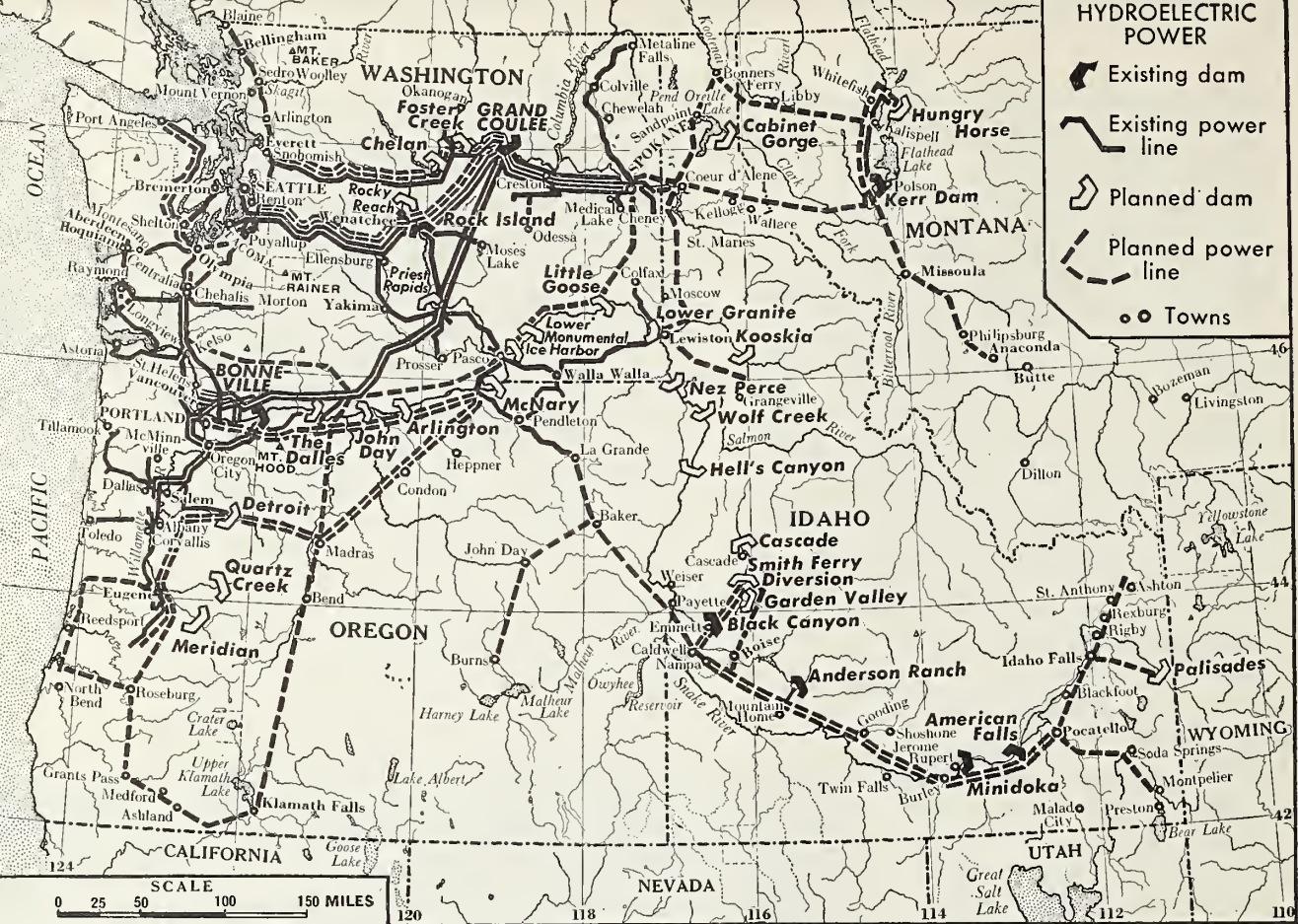
During the war, work stopped on the project. Power from Grand Coulee was ready just in time to help build airplanes and ships. Because of its power, the Northwest also became one of the principal aluminum-producing areas of the country. The production of aluminum from the ore requires electricity in huge quantities.

Farther down the river is the Rock Island Dam, the oldest one on the Columbia. Still farther down is Bonneville. Scattered over the region, on tributaries of the Columbia and on other rivers, are many smaller hydroelectric plants. Some belong to the government, some to cities, and some to private companies. During the war, all were joined by one huge network of power lines.

More hydroelectric power is produced in California than in any other state. California has many small dams and power plants. In the northern part of the state is Shasta Dam, one of the great dams of the West. But with all its water power, there is still not enough. For many of the industries of southern California, power comes from Hoover Dam, on the Colorado River where it is the boundary between Nevada and Arizona.

A big dam is an impressive sight. It is a concrete wall across a river. Water stands near the top on the upstream side of the dam. Waste water boils over the top or through openings near the top. The places arranged for water to spill over are called spillways. The spillways can be opened or closed according to the amount of water that is to be allowed to escape.

The water pouring over the spillways and churning itself into foam at the foot of the dam is not doing any work. You cannot see the water that does the work. It passes through giant tubes, called penstocks, near the bottom of the dam. The penstocks at Grand Coulee are eighteen feet across. In them the water is under terrific pressure. Water is heavy. If you have ever carried



The power network of the northwestern United States. The map shows both finished and planned projects.

a pail of it, you know that. The average depth of the water at Grand Coulee is more than three hundred feet. Imagine lifting a pail of water 18 feet across and 300 feet high. You cannot even imagine it, of course, but that is what you must do to imagine the pressure of water through a penstock.

Beside the great mass of concrete in a dam, a powerhouse does not look impressive at all. It is usually a long, low building that seems almost deserted. To build a dam and powerhouse requires the work of many men for several years. To keep them in operation requires only a few men.

Modern water wheels are called water turbines. You cannot see them even when you are inside the powerhouse. They are enclosed in openings in concrete on the lowest level of the powerhouse. The turbine is face down, as the old Greek wheels were.

Can you imagine the pounding hoofs of 150,000 horses? Can you imagine the dust they would raise? Each of the turbines at Grand Coulee can produce 150,000 horsepower of energy, but inside a great hydroelectric plant everything is clean and quiet. A few men watch a few instruments on the wall. Now and then an instrument clicks. The tiny movements of the instruments tell the men all they need to know about the working of the power plant and the movement of electricity over the wires.

Near the turbine there is a faint swishing sound, but you see no motion. Above the turbine rises a steel shaft. At the top of the shaft is the rotor of the big generator. The great shaft turns silently and so smoothly that you do not see it move. Outside the generator you can see nothing. If you were inside, you could see the great rotor whirling



U. S. Bureau of Reclamation, Coulee Dam

Water from the Columbia River pours through the spillways of Grand Coulee Dam, the largest in the world.

above your head, but you would hear only a high-pitched humming sound. There is nothing to give you even a hint of the terrific power that is being produced.

It is not always necessary that there be a dam to raise the water level for a power plant. There need only be a great weight of water. At Niagara Falls there is no dam. The water thundering over the falls does not produce the power, either. Great penstocks quietly take in water from the river above the falls and conduct it to a power plant at the foot of the cliff.

Canadian power. In water-power resources, Canada is one of the most fortunate countries in the world. Look at the map on page 200. It shows the places where water power has been developed and where it could easily be developed.

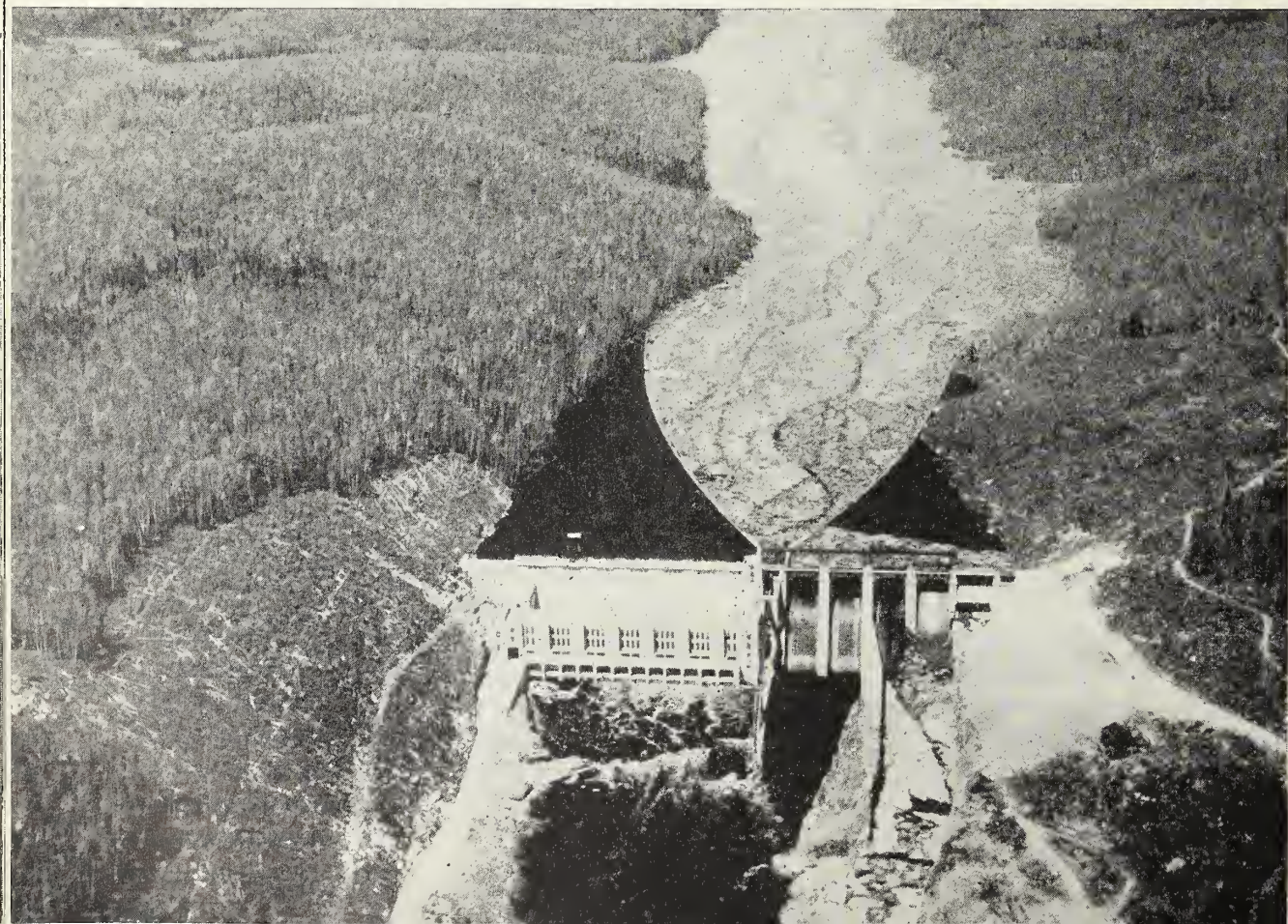
Of the power used in Canadian industries 80 percent is hydroelectric power. Without this cheap, abundant power, some of the industries would not be possible. A chief industry is the manufacture of wood pulp and paper. More newsprint paper is made in Canada than in any other country. Two resources are necessary for the manufacture of paper—forests and power. Canada has the forests, as you know. Newsprint paper must be cheap. Expensive power would make it too costly; but water power is cheap, once the power plants have been built.

The machinery and smelters of the great nickel-copper mines east of Lake Huron are operated by hydroelectric power. So is the machinery in the asbestos mines you read about on page 149. Gold and silver mines far to the north, zinc and lead mines in the Rocky Mountains, copper mines in many



Extent and development of Canada's many and widely scattered water-power resources.

A hydroelectric plant in a Canadian river that flows through coniferous forest. You are looking upstream. Floating logs give the river above the dam its light color. The logs are on their way to a pulp mill. A special flume next to the power house allows them to pass the dam.



places—these mines, with their refineries and smelters, are run by hydroelectric power. Even coal mines use hydroelectric power.

Without hydroelectric power, many Canadian mines could not operate. Some of the mineral deposits are in sparsely populated country with poor transportation. The deposits could not be worked if coal had to be brought to the mines for power.

Canada has many deposits of low-grade ore. If more expensive power had to be used, mining and smelting the ore would be too costly. Fortunately, Canada has such widely scattered water-power resources that every mining region can use water power.

Power in Europe. In general, western Europe does not have much water power, and most of the electricity is produced in steam plants. The wide, slow rivers of the North Plain in Europe are fine for transportation but not of much use for power. One of the few large dams in northwestern Europe is on the Shannon River in Eire.

The Scandinavian countries have abundant power. Most homes have electricity. Industries, too, are run by electricity. The iron mines in northern Sweden and the railroad connecting them with both coasts are all operated by electricity. So are most of the other railroads. Hydroelectric power runs most of the sawmills, pulp mills, and factories. Swedes have been pioneers in the use of electric furnaces in metalwork because they have no coal but much electricity.

Switzerland is another country with great hydroelectric-power resources. There, too, railroads and factories run by electricity. Many homes have a small machine or two operated by electricity. In their spare time, members of the family make small articles or parts of larger articles that will later be assembled in factories.

Most of the mountainous regions of Europe have water-power resources. To Italy they are very important, because Italy has no coal. There are many power plants in eastern France, in southern Germany, and in Austria.

Southeastern Europe has great potential power, but not much has been developed.

The people of the Soviet Union are making great efforts to develop their hydroelectric resources. Their first great dam was on the Dnepr River near Dnepropetrovsk. During World War II the Russians themselves destroyed the dam and power plant to keep the Germans from using them when they invaded the Ukraine. After the war, when the Germans were gone, one of the first great tasks was the rebuilding of the dam.

When they destroyed the dam, the Russians left the foundation to make the rebuilding easier. The new generators were made in Schenectady, New York. Work was rushed, but it takes a crew of men about a year to make a generator. When built, it had to be shipped across the ocean and set up. The first power from the rebuilt plant was produced in the spring of 1947.

Since the war, many new power plants have been built in the Soviet Union. Plans call for a power network in each region. Where possible, hydroelectric power is used. Where there is no potential water power, steam plants furnish power.

Problems of conservation. Far more water power is being wasted than is being used in the world. Conservation of water power means something very different from conservation of coal or oil. The only way to conserve water power is to use it. Water that is not used to turn a water wheel today cannot be saved to turn a wheel some other time. It flows away to the ocean. Fortunately, the rain goes on falling and the rivers stay full of water. There will be no less water power for the people of the future because we have used all we need.

The more water power we use, the more fuel we conserve, but only a little more than a tenth of the estimated potential water power of the world is in use. Why do we go on using steam engines? Why not use all the water power first and then supplement it with steam power?

Most of the rivers with the highest potential water power are not in industrial regions, and at present it does not pay to send electricity much farther than two hundred miles. The largest rivers in the world, with the most potential power, are in the tropics, but there is not one great industrial region in the tropics.

Sometimes the industries are taken to the power. In the northwestern part of the United States, in the southern Appalachian region, and in the Tennessee Valley, hydroelectric power and industries have grown up together. The same thing has happened in the Soviet Union. The people in India have great plans for developing industry and hydroelectric power together. No doubt this will be done in other parts of the earth, but there are difficulties.

For example, it is estimated that about 40 percent of the potential water power of the earth is in Africa, chiefly in tropical Africa. Tropical Africa does not have all the needed raw materials for great industries. Transportation is difficult. The climate is not favorable for good health and hard work. There are not enough workers, but in Europe and America there are millions of people who cannot make a living except by manufacturing. Should they all move to Africa? Most of them would be very unwilling.

Power for the future. Several other power sources have been suggested. A few scientists have been trying for years to find a way to use the heat of the sun to make electricity. Most of them have been working with the idea of giant reflectors to focus the sun's rays on a tank of water to make steam. If you have ever focused the rays of the sun through a magnifying glass, you know that the focused rays are hot. They will easily set fire to a piece of paper.

The tides are another possible source of power. They have been used in a few places. Twice every day the surface of the ocean bulges up and then sinks again. This movement of the ocean is the tide. The water is

lifted by the attraction of the moon and sun as the earth's surface turns beneath them.

Tides run into narrow inlets and river mouths with great force. Here is a vast source of power going to waste, but no tidal power plant has ever worked satisfactorily. No doubt the problems of proper equipment could be worked out, but we have no answer to another problem. It is the same problem that troubles the people who wish to use sun power. Power cannot be stored.

Electricity must be made as it is needed. The sun shines only in the daytime, and not always then. The tides rise twice a day and sink again. Neither sun nor tide would furnish continuous power, and that is what we must have. It is possible that the problems will be solved sometime. Other problems have been solved that once looked impossible.

No doubt you have been reading in newspapers and magazines about atomic power. For all we know now, people in the future may use nothing else; but there, too, difficult problems must be solved. People have been dreaming about atomic power for a long time, but they dreamed about it as a possibility of the distant future. Then, during World War II, hundreds of scientists from a number of countries worked together to make the atomic bomb. The process that makes the bomb explode can also produce power.

On page 179 you read about elements. There are fewer than a hundred elements. Among them are all metals except alloys. Elements are themselves made up of tiny particles called atoms. Not many years ago scientists believed that an atom was the smallest possible particle of anything. Then they found that some kinds of atoms could be broken up, or split. When an atom is split, it changes to an atom of another element and at the same time gives off energy.

For a number of years scientists were able to split atoms, but they could not keep the process going. What the scientists were trying to do was set up a *chain reaction*; that is, they wanted the energy from one splitting atom to go on splitting other atoms, releasing

energy all the time. They finally succeeded with uranium atoms.

It is not hard to build a power plant using the energy from splitting atoms. Much energy is released in the form of heat. The heat can be made to boil water, and the steam can be made to run a turbine which will turn a generator and produce electricity.

From the time the steam is made, there is no difference between atomic power and power produced by burning coal. The problem is how to make atomic power safe. Heat is not the only kind of energy given off by splitting atoms. There are also very dangerous rays. Some, like X-rays or the rays

given off all the time by radium, are stopped by a sheet of lead. They are no problem. Others, still more dangerous, pass through lead. Great masses of concrete are needed to stop them. Even the steam is dangerous, and the water after the steam has condensed. One of the leading atomic scientists has said that at least a hundred tons of shielding materials are necessary to make the equipment perfectly safe.

Do you see why atomic power could not be used for airplanes or automobiles? It might be used for large ships. More probably, however, it will be used for a long time only in large power stations.

A WORKSHOP ON POWER

It is not necessary that you learn exactly how all kinds of water wheels and engines work. Some people understand such things easily and some do not. Those who understand are not necessarily brighter or more intelligent than those who do not understand. But there is one thing everyone can understand—the importance of power and energy in our everyday lives. For a few days, try making a list each evening of how power has been useful to you that day.

Your Community as a Laboratory

If you list all the ways in which power is useful to you, you are sure to become curious about the sources of power in your community. You cannot very easily separate power and energy, and so you may consider them both together.

POWER IN YOUR COMMUNITY

Your class may decide how to work and report on the following questions. You will save time by dividing the class into groups.

Where does your community get electricity? Is it hydroelectric power or is it generated by steam? Where is the power plant? Does it serve your community only?

What makes the water come out of the taps at school? How do you get water at home? Unless you get it from a flowing

well or spring, some kind of power must be used—perhaps the power of your muscles.

What kinds of power are used for transportation in your community? Practically all automobiles have gasoline engines. You can safely start your list with gasoline engines. Then you can find out whether any Diesel-powered busses or trucks serve your community.

Perhaps some of your transportation is powered by electricity. You may not have streetcars or an electrified railway, but don't forget up-and-down transportation. Most elevators are operated by electricity.

What kind of power is used to operate trains on the nearest railway? Perhaps you already know the difference between Diesel and steam locomotives when you see them. If not, this is the time to learn.

What kinds of power are used in the industries of your community? Do factories have their own power plants, or do they use electricity from the community supply? If you live in a large city, you cannot make a power survey of all the industries. Find out about a few of the largest ones, or you may select those nearest home.

If you live in the country, what kinds of power are used on your own and neighboring farms? What kinds of power pull the farm machinery? Do most of the farms have electricity? Select one or more highly mechanized farms and list all the jobs done by power, with the kind of power for each one.

USE POWER SAFELY

The use of great quantities of power has made living more comfortable. It has made work much easier. It gives us many more things to use than our ancestors had. But power is dangerous.

The widespread, everyday use of power is so new that people have not yet learned to live with it. To some older people all the traffic on the highways, all the streamlined trains, all the electrical gadgets at home still seem strange. They do not seem strange to you. They have been part of your world ever since you were born. We say old people "live in the past." Young people should learn to live safely in the present.

Highway accidents and accidents with electricity happen every day. Nearly all these accidents are unnecessary. They happen because someone does not know how to live in an age of power.

Make up two sets of safety rules:

1. Rules for highway safety. Automobile clubs, policemen, and safety organizations will help you.

2. Rules for safe use of electricity. Appliance dealers and people who work for the electric company can help you.

Make your lists brief enough so that you can learn the rules by heart. In this book there are very few things that you are asked to learn by heart, but you should know safety rules so well that you cannot forget them. When you know the rules thoroughly yourself, teach them to your younger brothers and sisters and the younger children in school.

If an accident occurs in your community, find out what safety rule somebody forgot.

Test Your Skill and Knowledge

If you can carry out successfully the following activities, you will have proved that you know more about power than most grown-up people know.

WHO LIKES TO USE HIS HANDS?

One kind of skill is skill in making things. Few people have it without long training. If you are one of the people who understand easily how things work, try your skill at making models of water wheels and engines.

A POWER QUIZ

- Which of the following terms does not belong in the group?
a. overshot wheel *c.* Watt's engine
b. water turbine *d.* Greek wheel
- Which of the following is not a form of energy?
a. heat *c.* light
b. power *d.* foot-pound
- Coal is burned under a boiler to produce steam. The steam turns a rotor with many small blades. Which of the following kinds of engines is it?
a. Diesel *c.* atomic
b. jet *d.* steam turbine
- Arrange the following terms in the right order, so that the things they stand for will produce power and run a machine.
a. water turbine *c.* motor
b. wires *d.* generator
- A swift river flows along unused. Which of the following does it have?
a. horsepower *c.* chain reaction
b. potential power *d.* technology

A TIME CHART

This chapter has a good many dates for inventions and discoveries. You have not been asked to learn them, but you should remember in a general way about how long ago the inventions and discoveries were made.

People remember things better when they see them in the form of a chart. Make yourself a time chart for developments in the use of power. You may use a long sheet of paper or the blackboard.

Start with the invention of the Greek wheel and divide your chart, up and down, into equal spaces for centuries. Then put the inventions and discoveries in their correct centuries. When you have an exact date, write it at the left.

Save the chart for later use.

ADDITIONAL INFORMATION

Your government can furnish you with additional information on hydroelectric power and rural electrification. Railroad companies, air lines, and the manufacturers of machines and electrical appliances may have booklets to send you.

Power is a very live subject. Watch your newspapers and magazines for news about it.



Industrial regions

Region of intensive industry

Makers and Builders

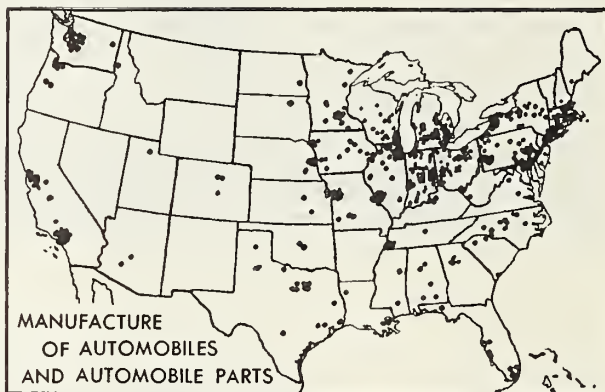
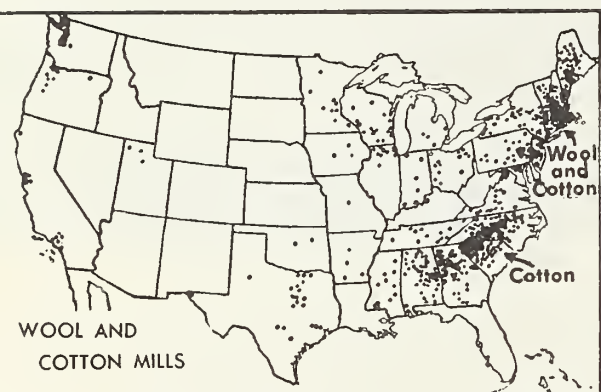
INDUSTRIES AND INDUSTRIAL REGIONS

Everything we have comes from the earth, but there is scarcely anything we use just as we get it. Can you think of anything you have used today that was not processed in some way? In the stores of your community you will find almost nothing that has not been manufactured or at least processed to some extent. Most nearly natural are the fruits and vegetables on the shelves of the grocery or fruit stores, but even they have been cleaned and graded. Some vegetables, such as rutabagas, may be dipped in wax to keep them from drying out. Oranges may be ripened in rooms filled with gases that bring out the color in their skins. Many vegetables are trimmed and tied in bunches.

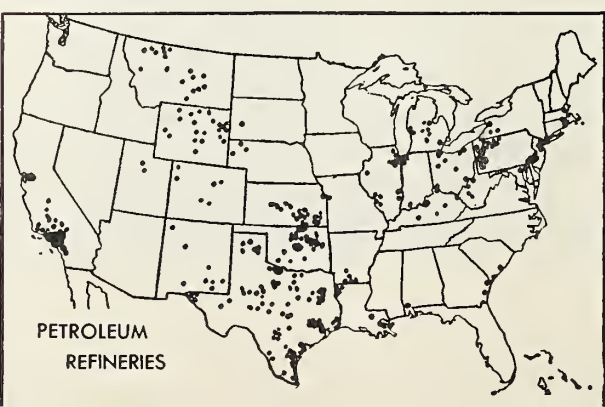
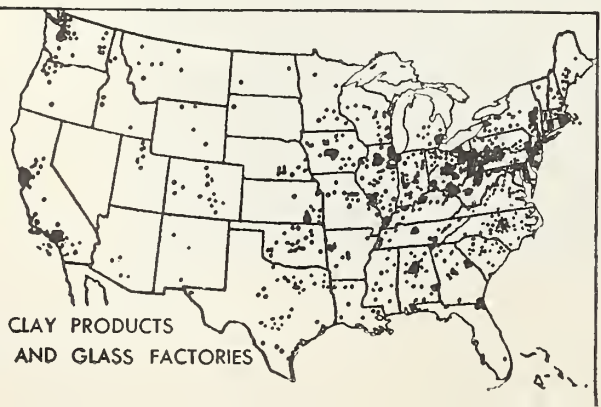
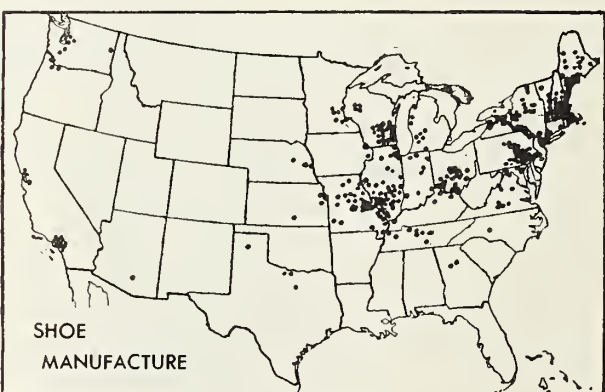
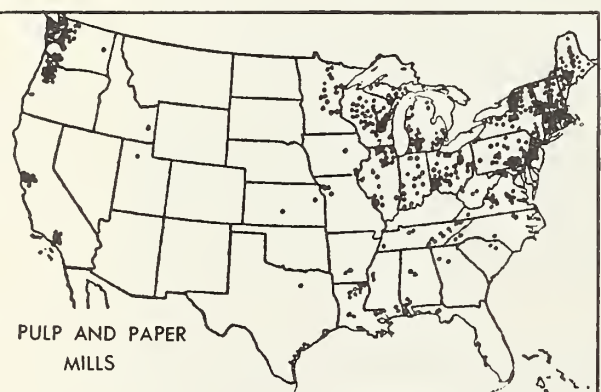
Except for food, we use very few things that even look like the materials from which they were made. Think of your own clothes,

your home, its furniture, and all the household equipment. All of them are manufactured articles. The machines that made them were manufactured. Raw materials were processed before they went to the factories. The people who raised the raw materials or dug them from the earth used tools and machines that were manufactured.

Probably there is not a community in North America without some kind of manufacturing or processing. Wherever you live, you have a chance to see people changing raw materials into useful products. A material may go through several processes in different places before it is ready to use. The first processing may take place on the farm, as when a combine or threshing machine separates grains of wheat from their husks. Next the wheat goes to an elevator;



On these United States maps the black areas show the distribution of the industries named.



then to a flour mill. The flour is shipped to a bakery. With other ingredients added, the flour becomes bread, pies, cakes, and cookies. That last step may be taken in your own kitchen at home, not in a commercial bakery.

Wherever you live, you can study some kind of manufacturing or processing at first hand. Make a real study of manufacturing in your community. As a guide, use the Workshop at the end of this chapter.

Although you can see some kind of manufacturing almost anywhere, there are regions in which it is of outstanding importance. Those are the industrial regions shown on the map at the beginning of this chapter. In your earlier study of geography, you have read about industrial regions many times.

You know that industrial regions are always regions of dense population. You can see that by comparing the industrial-regions map with the population map on pages 372-373. The map on pages 374-375 shows that

industrial regions of the United States are regions of many large cities. Look also at the occupation graphs on page 380. The graphs include three cities from the great industrial region in the northeastern quarter of the United States. In two cities, Chicago and Detroit, more workers are in manufacturing than in any other group. In New York, the service-industries column is tallest, but manufacturing is second. It outranks both trade and transportation, even though New York is the world's busiest seaport.

Now look at the maps on the page facing this one. These maps help you to reach another general understanding about industrial regions. Each of the industries shown is widely distributed over the country; but if you had the symbols for all the maps transferred to one map, they would pile up several layers deep in the principal industrial regions. Great industrial regions, in other words, are always regions of many and varied industries.

WORKERS IN THE FOOD INDUSTRIES

Cooking is the oldest method of processing food. No people are known, however primitive, who did not cook at least part of their food. Roasting and broiling over a fire were the first methods of cooking foods. They are the only methods possible without cooking utensils. There were no real cooking utensils before the New Stone Age, but there is good evidence that people of the Old Stone Age cooked their meat.

After pottery was invented, cooking was done in clay pots. They were used even after metal became common for tools. The ancient Romans also had cooking utensils of copper, brass, and, sometimes, iron that looked very much like our own. There was a large assortment of pots, pans, frying pans, kettles, spoons, ladles, tongs, strainers, knives, and cleavers. If you have a chance to visit a large museum, you may be able to see some of the Roman cooking utensils.

Home Processing of Food

Although cooking is a method of processing food, we usually mean a little more than that by the word. When we talk about home processing today, we mean such things as canning or drying fruits and vegetables, curing meat, and making butter or cheese. Butter and cheese are perhaps the oldest processed foods.

Dairy products in ancient times. A very long while ago, probably early in the New Stone Age, people began to use milk. Cows and goats are the most usual milk animals now, but sheep are milked in many places. Also, Arabs of the Sahara and Arabia milk camels and donkeys; the nomadic Mongols of central Asia use mare's milk; Lapps and Eskimos milk their reindeer; the people of southeastern Asia milk water buffaloes.

Milk is very perishable. Except in cold countries it will not stay sweet without refrigeration. Fortunately, sour milk is good to drink and just as nourishing as sweet milk, but even sour milk will not keep long. It spoils and cannot be used for food.

There are two stories about ancient inventions of dairy foods. Probably neither one is actually true as it has come down to us. The stories are traditions, not historical records. Still, they might be true. It is very likely that the inventions were made in some such way, for they were made long ago in the days when most inventions and discoveries were accidental.

One story tells about a man of central Asia who went out for a day's work herding animals. He took a skin bag of sour milk for food. All day, as he rode his horse, the bag of sour milk bounced behind him. When he opened it to take a drink, he found lumps of a delicious yellow substance—butter. However they learned to do it, people were already making butter at the beginning of history.

The other story is not very different. It is about an Arab who went on a journey, leading a donkey. Food for the journey was tied on the donkey's back. Among other things, there was a bag made from the stomach of a sheep. The bag was filled with milk. It was a hot day, and the journey was long. The Arab did not stop to eat until evening. Then he discovered that the milk had divided into a liquid and a white solid. The white substance was good to eat. In fact, it was the beginning of cheese. That the milk was carried in a bag made from a sheep's stomach is important. The stomach linings of animals contain a material called rennet. It helps the animal to digest his food. Added to milk, it causes the milk to separate into a liquid called whey and a solid called curd. This separation is the first step in making cheese.

Cheese is a very old food. It is mentioned a number of times in the Bible. Almost every group of people who keep animals for milk

make some kind of cheese. Even more than butter, cheese is a means of preserving food value in milk. Butter keeps for some time, especially if you do not mind its being a little rancid, but cheese keeps much longer.

In ancient times everyone kept milk animals and made butter and cheese—even many city people. Some dairy products were sold in the markets, but they were sold by farmers who kept the animals, made the butter or cheese, brought the products to town in their own carts, and sold them to the people who would use them, not to store-keepers. The preparation of dairy products was not commercialized or even specialized until fairly recent times.

Old-time millers. You know about one kind of food preparation that was specialized in ancient times—the grinding of grain. You read about it on pages 185–187. As you read, milling did not change much during the Middle Ages. Thousands of water wheels of the Greek type were used. They were like the one in the diagram on page 186.

The mill diagramed on page 187 was a commercial mill. There was a miller who probably had an assistant or two. In cities, the miller might have bought grain and sold the ground meal or flour. In smaller communities, farmers usually brought their grain to the mill and gave the miller a share of the flour as payment for the grinding. The miller kept as much of the flour as he needed for himself and sold the rest.

Less than fifty years ago in America, it was still customary for farmers to take wheat and corn to the mill, wait for them to be ground, then take the flour and meal home with them. Every small town and almost every village had its gristmill. There were already large wheat-growing regions from which grain went to city mills for grinding. Flour was sold to city people or exported.

Preserving food on the farm. The problem of preserving and storing food has bothered people ever since they stopped

being hunters and collectors and settled down to live in one place. The great advantage of grain as a food is that it will keep without processing if it is stored in a fairly dry place. Many roots and a few fruits, such as apples, will keep for a long time if they do not get too warm. They were therefore stored in cellars or in caves dug into hillsides. Most foods do not keep so easily.

Perhaps the oldest method of keeping perishable food is by drying. Have you ever heard of the pemmican the Indians made? Pemmican is dried meat. The Indians cut the meat into small, thin pieces and hung them on a line to dry. They became as hard as chips. The dried meat could be eaten just as it was. Chewed a sliver at a time on a journey, it was very nourishing. More often, though, the Indians processed it further. They ground the chips of dried meat between stones. Then they mixed fat with the meat fragments.

Fish, too, have been dried for a long time. The simplest method is to split them open and dry the two thin halves in the sun and air. Some fish are salted before they are dried. Smoking is another means of preserving meat and fish.

In the chapter about farming you read how subsistence farming changed to commercial farming in large areas of the earth. If you compare the map on page 53 with the map at the beginning of this chapter, you will see that the regions of commercial farming are the same as the industrialized regions of the world, or are close to them. Commercial farming usually means large-scale processing in specialized plants.

There are exceptions. Commercial ranching is carried on for the most part in regions of sparse population and few industries. Always, though, the regions of any kind of commercial food production must be within easy reach, first, of processing plants, and second, of the consumers. *Consumers* are the people who use a product.

Look at the occupation graph for 1840 on page 381 and the population map on page



Eisenstaedt from Pix

This Danish woman is stringing a row of herring on a long stick to dry in the open air. These fish were caught in the neighboring Baltic Sea.

376. Map and graph really tell you the same thing. In 1840 most of the people of the United States were farmers. Most of the farmers were subsistence farmers. Their greatest problem was keeping a supply of unspoiled food for the whole year. Bread—white bread or corn bread—made up a much larger part of the diet than it does today. Grain was easily kept. It needed only to be dried and stored in a sheltered bin or corncrib. Grain was taken to the mill for grinding, but baking was done at home.

In the fall the farm family prepared most of the year's supply of meat. The meat that was used was almost entirely pork. Early on a fall morning the farmer, usually with neighbors to help, killed the hogs, scalded the carcasses in huge kettles of water boiled out of doors over open fires, scraped off the bristles, and cut up the meat.

Men and women both worked to process the meat. The meat along the backbone and a few other parts were kept to eat fresh. They had to be used within a day or two unless the weather was cold. Most of the meat was cured, however. Some of it was put into barrels of strong salt water. Later the hams, shoulders, and bacon were sugar-cured and smoked. There were different methods. Usually the meat was covered with a mixture of salt, sugar, and a little saltpeter, a chemical. Covered with this mixture, it was stored in a cool place for several weeks. Then it was hung in a tight little building called a smokehouse. A small, smoky wood fire was kept burning for several days until the smoke had penetrated the meat. Salt, sugar, and smoke are all preservatives. Properly cured meat would keep all winter and through the next summer.

Many farmers made most of the hog, except for the hams and bacon, into sausage. First the meat was ground or chopped into small pieces. Part of it was stuffed into casings, which were the carefully cleaned and washed intestines of the hog. Stuffed sausage was usually cured and smoked like

hams and bacon. Part of the meat was patted into small cakes, cooked, and packed in heavy jars. Then melted lard was poured over the sausage.

Lard was one of the most important products of a hog. Frying was the most popular method of cooking, and most fruit was eaten in the form of pies. Everyone used lard for frying and as shortening in pies. The fat was cut from the carcass and melted in a large kettle. Then it was strained and put away in jars.

Potatoes, turnips, apples, and a few other fruits and vegetables could be kept for a long time stored in cellars. Other fruits and vegetables were dried. The women of the household made many preserves, jellies, jams, and pickles. Sugar or vinegar kept them from spoiling.

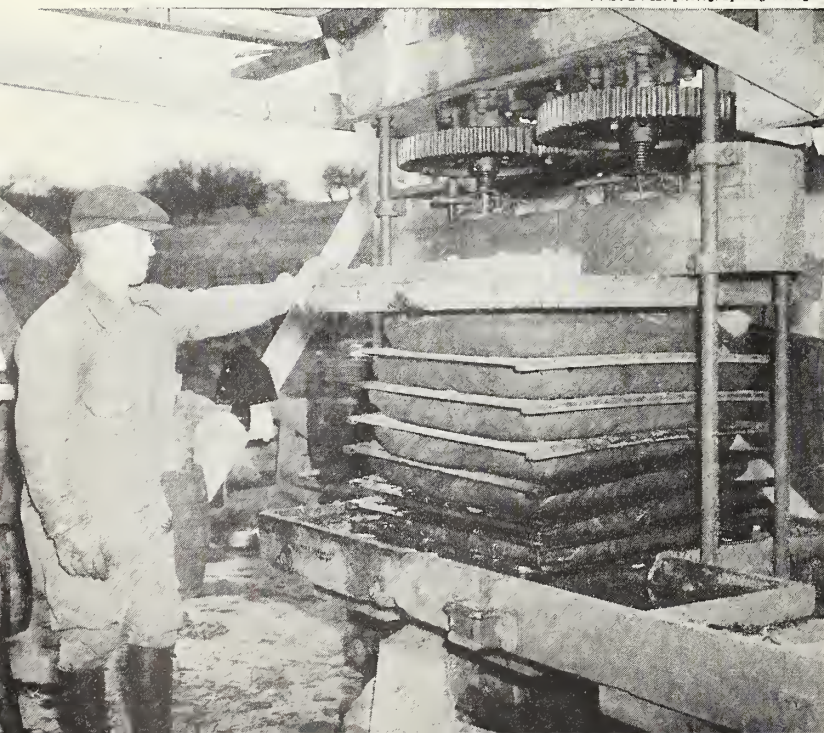
The vinegar was usually a home product. It was made from apples. Some farmers had hand presses for getting the juice out of the apples in the fall, but most communities had a commercial cider press. Farmers took their apples to the press to have the juice squeezed out. To make vinegar, the apple juice, called cider, was allowed to ferment.

Even townspeople ate mostly foods processed on farms. Ham, bacon, butter, lard, and eggs were the farmers' surplus. Vegetables and fruit could be bought only "in season."

The change from farm processing to the modern food industry came about slowly. Many farmers still cure their own meat. About a third of the butter used in the United States is still churned on farms. Women on farms still make jams and jellies, and they can large quantities of fruits and vegetables. The larger part of our food today is commercially processed, however. About 10 percent of all factory workers in the United States are in the food industries.

Operating the presses of a small commercial cider mill in an apple-growing region in the state of New York.

U. S. D. A. photograph by Forsythe



The Dairy Industry

Methods of making butter and cheese were discovered more than five thousand years ago. The products were made on the little subsistence farms of the New Stone Age. Less than a hundred years ago they were still, for the most part, farm products. Because cheese making at home is more difficult than buttermaking, cheese factories were built earlier than butter factories.

Today even liquid milk is processed before it is sold. Milk-processing plants and cheese and butter factories are widely scattered over the earth, but you would not find them everywhere. Some regions have few cattle. Where cattle are kept in regions of subsistence farming or nomadic herding, dairy products are still prepared at home. Factories in which milk and milk products are prepared for use are mainly in the industrialized regions of the world.

A map on page 83 shows where dairy cattle are kept in North America. Plants for preparing dairy products are scattered over the whole area in which dairy cattle are kept. Every city has a milk supply, and even with the most modern methods milk is hard to ship. For this reason, we find that dairy cows are kept near large cities whether the region is especially good for dairying or not, and every city has plants where milk is prepared for use.

Butter, cheese, and a few other milk products can be shipped almost any distance. Most of them, therefore, are produced in the regions which show the most dots for dairy cattle on the map. In some plants one product is manufactured. Others produce a number of different dairy foods. The following paragraphs tell how the work is carried on in such a plant, which is usually called a creamery.

Preparing milk for sale. The first step is collecting the milk from the farmers. The farmer may take it to the creamery himself, but many dairy companies send their own

trucks out to collect cans of milk from the farmers. Some farmers sell only the cream. Skimmed milk is a valuable food for calves, pigs, and chickens, and a farmer may wish to keep it on the farm. In that case he must have a machine called a separator to separate the milk from the cream.

At the dairy plant, milk is prepared for the milkmen to take out to the customers or for sale in stores. First it is tested. Even if it is not to be used for making butter, it is tested for butterfat. Milk that has too little butterfat—too little cream, in everyday language—cannot be sold as whole milk. Milk from different cows varies greatly in the amount of butterfat. At the dairy plant, milk from many farms is mixed so that it will all have the quantity of butterfat required by law, and so that all customers will get equally good milk.

Another test is for the number of bacteria. A small measured sample of the milk from each farm is put under a microscope, and bacteria are counted. If the count is too high, the milk is not accepted. This is not done for every farm every day, but it is done often enough to make sure that each farmer is meeting the standards of cleanliness that have been set up.

Then the milk is pasteurized. The process is named for the French scientist, Louis Pasteur, who discovered many years ago that food is spoiled by the action of bacteria. Pasteurizing means keeping the milk at a temperature just under the boiling point long enough to kill the bacteria.

Most milk sold today goes through another process. It is homogenized. You need not learn that big word unless you want to, but you will probably find it printed on milk-bottle caps, or on the pasteboard carton if that is how you get your milk. The butterfat in milk is in tiny drops. These drops are lighter than the rest of the milk and come to the top when the milk stands in one position for a short time. The process of homogenizing breaks up these little drops of fat into particles so small that they do not

rise to the top. The cream remains scattered through the milk.

After it has been cooled again, the milk goes to the bottling machine. Most milk is sold in quart bottles or in paper cartons. The bottling machine fills each container as it passes on a conveyor.

Buttermaking. Another part of the plant is the butter factory. Making butter is a very simple process. Cream, usually sour cream, is the raw material for butter. The cream must be churned, or splashed about for a time. Churning makes the tiny drops of butterfat gather in clumps. In a butter factory the churn is usually a large steel cylinder rotated by machinery. The butter appears as yellow lumps floating in liquid. Workmen scoop these yellow lumps of butter out of the liquid and put them into a machine that mixes and squeezes them to get all the liquid out. While the butter is still soft, it is packed in kegs or made into bricks, usually weighing a pound. Often the pound of butter is divided into four sticks, each weighing a quarter of a pound.

Cheese making. Cheddar is the most popular cheese made in America. Except among cheese makers and dealers, it is usually called American cheese, although it was invented in England. Cheddar is the kind you are most likely to see being made in a small factory. The cheese factory may be part of a creamery, or it may be a separate plant.

Ten pounds of milk, a little less than five quarts, are needed to make one pound of American cheese. The milk is poured into long open vats, usually made of stainless steel. First the milk is warmed. Then the cheese makers add rennet and a substance called a starter. The starter contains bacteria of the proper kind to develop the flavor of the cheese.

In the vat the milk separates into curd and whey, as a result of the action of the rennet. The liquid whey drains off and the

cheese makers mix and knead the curd until it becomes a rubbery mass. A machine cuts it into strips, which the cheese makers pack into molds. In a press the cheese is forced into a solid cake.

That finishes the process of making the cheese so far as the cheese makers are concerned, but it is not yet good to eat. It is stored in curing houses to ripen. For very mild-flavored cheese, the ripening time may be as short as two months. For a very sharp flavor, it may be two years. The ripening is brought about by the action of the bacteria in the starter.

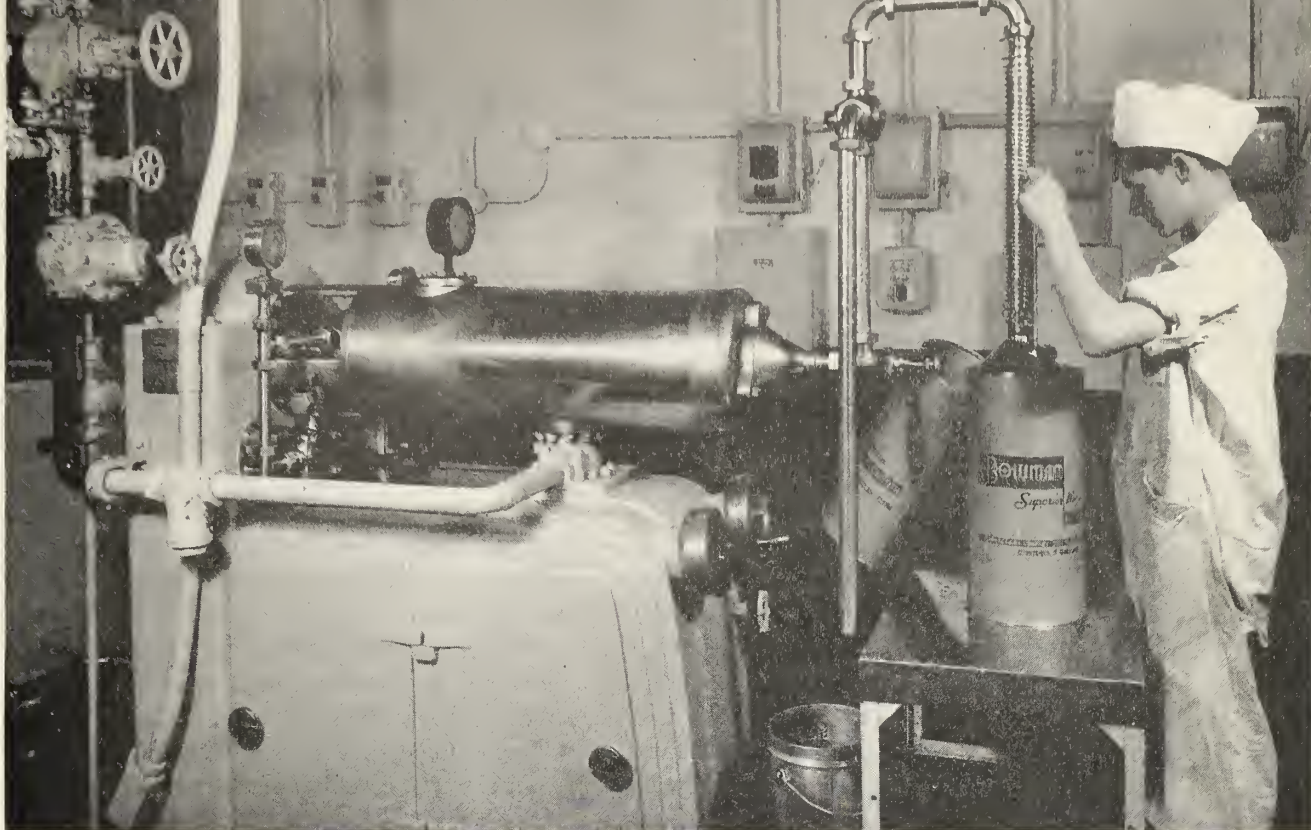
There are hundreds of kinds of cheese in the world. Details of manufacture differ, but the basic processes are the same. Many famous varieties are made in Europe. Sometimes even a small village has become world-famous because of a fine variety of cheese invented there. Americans import many of these cheeses, but the most popular European types are made in America also.

Switzerland, Italy, France, the Netherlands, Denmark, and England all produce world-famous varieties of cheese. As in America, the cheese factories are usually small, scattered through the dairy regions.

Ice cream and other milk products. An ice-cream factory is another department you would find in many creameries. Perhaps you have made ice cream in a small home freezer. The same processes are used in an ice-cream factory, but on a larger scale and with power machinery. Gelatin and flavoring are added to milk and cream. To beat in tiny bubbles of air, the mixture is stirred while it is freezing. Otherwise the ice cream would be hard and soggy.

Milk chocolate is another milk product that you probably like. Dutch and Swiss varieties are especially famous. Manufacturers use imported cacao beans and milk from dairy farms in their own countries.

On the shelves of every grocery store you will find cans of evaporated milk and condensed milk. These have had some of the



Courtesy Bowman Dairy Company

Modern, sanitary plants like this one produce America's favorite dessert, ice cream, in many varieties and flavors. Ingredients are blended, homogenized, and cooled. Then the mixture is frozen and stored.

liquid evaporated away, but all the food value of the milk is still there. Powdered milk is milk reduced to a dry powder. There is also chocolate milk, which is quite a different product from milk chocolate. Milk chocolate is candy. Chocolate milk is liquid milk flavored with chocolate.

The Meat Industry

Do you know what meat is? That simple word does not always mean the same thing. It has been used with more than one meaning even in this book. Probably you did not notice, because the different meanings are so common. The rest of the sentence or paragraph in which the word appears usually makes its meaning clear.

When your mother talks about the meat dish of a meal, she may mean beef, pork, lamb, chicken, or fish. People who work in the meat industry use the word only for beef,

pork, and lamb or mutton. Methods of preparing other animals for food are quite different, and the work is usually done by different companies in different plants.

History of meat packing. The commercial processing of meat is called meat packing, and the plants in which it is done are packing plants. The terms came into use long ago, when meat really was packed.

As you have read, so long as most people in America were farmers, most meat was prepared on farms and used at home. Even for people who lived in cities and towns, most of the meat came from the surrounding country. Owners of meat markets in the towns sent out buyers who drove from farm to farm looking at animals the farmers might wish to sell. Employees of the meat market killed the animals and prepared the meat. Fresh meat had to be sold within a few days after the animals were killed. There was

no known way to keep fresh meat from spoiling. Only cured meat could be kept. Meat that could not be sold at once was prepared by salting or smoking or drying.

The cured meats were packed in barrels. Some kinds of meat—corned beef, for example—were packed in brine. Other kinds, such as hams, were packed dry. Thus the first large-scale processing of meat was really meat packing. Techniques and products have changed, but the name remains.

Far back in colonial times, a little meat was packed along the Atlantic coast. Most of it was exported. As the Middle West and the central South were settled, Cincinnati became the first great center of the meat-packing industry. Because of the quantities of pork cured there, Cincinnati was nicknamed Porkopolis, which means Pork City.

Because it was surrounded by good farming country and had the Ohio River for transportation, Cincinnati became the leading pork-packing city. River steamers carried barrels of ham and bacon down the rivers to New Orleans for shipment to ports in the East and for export to other countries.

Settlers pushed on to the west. Chicago, St. Louis, and other middle western cities became the centers of growing industries. Small-scale meat packing was carried on in these cities, as in nearly all cities surrounded by farm land.

In the meantime, cattle ranchers were settling the grasslands of the West. Ranching began in eastern Texas in the 1820's. For a long time the ranchers had no real market for meat. A few of the animals that they raised were driven to New Orleans and other southern cities, but for the most part the Texas ranchers could sell only the hides and horns of their cattle.

Now turn to the map for 1870 on page 377. Look at the lines of railroad stretching westward from the Mississippi River. They were built during the late 1850's and 1860's. When they reached the grasslands, the cattlemen of Texas began driving their cattle northward to the railroads.

The cattlemen found the grass so good that many of them decided to stay in the more northern regions. Within twenty years there were ranches all the way from Texas across the United States into Canada. Other people came from the East and from Europe to start ranching. Compare the population symbols on the 1870 and 1890 maps on page 377 to see what happened. The development of the meat industry led to the settlement of hundreds and hundreds of square miles in the West.

In 1865 the Chicago stockyards were opened, with packing plants beside them. The stockyards were a vast area of small cattle pens. Ranchers could send their cattle to the stockyards. There the animals were fed and cared for until they could be sold. The packers bought some of them. Others were shipped on to the East.

At first the packing plants worked only in winter, for the packers were trying to ship fresh meat as well as cured and packed meat. Then, in the 1870's, the refrigerator car was invented. Ice was put in compartments at the ends of the car, where it was not in contact with the meat. Cold air circulated through the car. The meat was hung from the ceiling so the air could move all around it.

Chicago now has the largest meat industry of any city in the world. Kansas City, Omaha, South St. Paul, East St. Louis, and Fort Worth are also great meat-packing centers. A map on page 206 shows the location of other plants. Not all packing plants are as complete as the one described below.

A disassembly line. Meat packers say that the assembly line was invented in the meat industry. Sometimes they call their arrangement a disassembly line. They take products apart instead of putting them together. An assembly line is a device for securing efficiency through division of labor.

This is how division of labor works in the meat industry. Carcasses come from the killing room on a moving conveyor. The conveyor is overhead, and the carcasses hang

by their hind legs. Hogs are dehaired. Their hair is mostly in the form of stiff bristles. The carcass is first dipped in a vat of boiling water to soften and loosen the bristles; then it goes through a dehairing machine. Hogs are not all the same size and shape, but knives on the end of flexible flaps of leather or rubber scrape off the bristles anyway. When enough bristles have accumulated, they are hauled away. They will be used in brushes, for upholstery stuffing and for many other purposes. The hog carcass next passes through flames to singe off the finer hairs and any bristles the knives did not get. At several points it passes through sprays of water to wash it.

Cattle, sheep, and lambs do not go through these processes. They are skinned. The skins are raw material for the leather industry. Wool from the lambskins is saved, too.

After the dehairing or skinning, the carcasses move on, still hanging on the conveyor.

They are carried past a line of men, each of whom has just one job to do. First the carcasses are sliced open and the insides are removed. The livers, hearts, and sweetbreads are kept for food. Intestines are cleaned for sausage casings. Heads and hoofs are removed, and the carcasses are trimmed. Then they are split through the middle of the backbone. The halves of carcasses are called sides of beef or pork.

Graders and inspectors. The meat goes next to a refrigerated room until it is thoroughly cooled. While the meat is there, we might stop to mention a few workers whom we have skipped so far. First, there are the men who grade the meat. Meat is graded according to quality. Grading begins with live animals in the pens, but the real grading is done after the carcasses are cleaned and hung up. Only experts can tell the quality of the meat by its appearance.

In an Argentine packing plant huge beef carcasses are being washed with hose and brush before being cut up and sent to the freezing room. A similar picture might be taken in any large plant in the United States.

Jules Bucher from Three Lions



Graders are among the most highly skilled employees of the packing company.

Inspection is another job that begins with the live animals and goes on to the trimmed carcasses. In all United States plants that sell meat outside their own state, this work must be done by inspectors from the Department of Agriculture. Perhaps you wonder why there should be a difference for meat sold outside the state. The Constitution of the United States says that the federal government may regulate interstate commerce. Under the rights given the government by this clause in the Constitution, the government has set up many rules about products traded from one state to another. The United States government has no legal right to make any rules about goods that are sold entirely within a state. Many states and cities have their own rules and their own inspectors.

Finished products and by-products.

When sides of meat leave the cooler, they move on a conveyor again, past a line of workmen. Each man removes one cut of meat. Most cuts can be removed with one

In a packing plant, there is much work that cannot be done by machines. Trimming hams is one of the highly skilled and highly specialized jobs.

Courtesy Armour and Company



slash of a large, sharp knife. Soon each man has a pile of the same cut. Some cuts are ready to sell. Others need further processing.

In a room filled with clean metal tables, men are trimming hams. Their sharp knives snip off tags of meat and fat, shaping the ham into a solid piece that looks attractive and will take the curing process well. The actual curing process is not very different from the farm process, except that it is done on a large scale.

Many hams are tenderized. This means that the meat is treated with fruit juices. Fruit juices have substances in them that make meat more tender. Pineapple juice and the juice of a tropical fruit called papaya are often used.

In another part of the packing plant men are boning pieces of meat. Pork shoulders, for example, are so bony that they cannot be sliced well. Often the bones are removed and the meat is rolled. Then it is cured like ham. The bones are not wasted. They may be boiled to make either gelatin or glue. They may be burned to make charcoal, used in refining sugar, or carefully cleaned and processed as raw material for bone buttons and other small articles.

In the bacon department are rows of slicing machines, which cut cured sides of pork into sliced bacon. The slices pass on a conveyor in front of rows of women workers. The women lay the slices in even, overlapping rows. They pick up a half pound and wrap it in waxed paper. Often two of the half-pound packages are put in a pound carton. Machines wrap the cardboard around the bacon to make the carton.

The sausage room is a fascinating place. Most sausage is a mixture of pork and beef, but some is all pork and some is all beef. There are many kinds. The meat is weighed to get the right amount of beef and pork. Then grinding machines grind it very fine. In large metal vats on wheels, salt, spices, and other seasonings are mixed with the meat. Now it is ready to be wheeled away to the stuffing machines. Sausage comes in

many sizes and shapes, but this is how the stuffing is done for ordinary link sausage.

The stuffing machine has an opening at the top for the ground meat and a spout at the side. The operator loads his machine with meat and works a easing over the spout. Many feet of easing can be pushed together on the spout. When everything is ready, the workman turns on the machine. Inside the machine is a press which squeezes the meat out through the spout. It fills the end of the casing and, as more meat is squeezed out, it pulls the casing off the spout. In fact, the whole length of casing shoots off the machine like a long, flexible rod. The rod of sausage drops on a clean metal table.

At the side of the table sit women workers. The meat inside the casing will be cold and firm later, but now it is warm and soft. A woman grasps the rod of meat in her two hands and gives it a turn. The meat separates and the casing twists into a thin string between her hands. She moves along, making twists at even intervals until the rod of meat has become a string of sausage links.

Some of the meat prepared in a packing plant is cooked before it is sold. Some is canned. Food products other than meat are prepared, also. The fat of hogs is made into lard. Selected parts of the beef fat, with skim milk added, become margarine.

A few by-products of the packing industry were mentioned earlier—for example, glue, gelatin, charecoal, and buttons from bones; leather from hides. Sinews, which you probably call gristle when you find them in a piece of meat, and hides are also raw materials for glue. From fats come glycerin, tallow for candles, lubricating oils, and oils used in processing leather. Animal organs called glands are very valuable by-products. From these glands are made some of our most important medicines.

A world industry. North America is not the only land with meat-packing plants. As you read earlier, commercial ranching is carried on in Argentina, Australia, and New



Courtesy Danish Information Office

Inspection of hogs in a coöperative bacon factory in Denmark. Denmark is famous for its bacon.

Zealand. A large part of the meat is exported. The animals are taken to packing plants for processing, as they are in North America. Those that are intended for export go through another process. They are frozen stiff. Frozen meat will keep safely even on the long sea voyage from Australia or New Zealand to England. Of course it must be sent in a refrigerator ship. On the ship the meat is stored in rooms that are cooled by chemicals in pipes, as electric refrigerators are cooled. The temperature must be kept below freezing.

Meat animals are raised in every country. In countries of western Europe the meat industry is important, but the densely populated industrial countries do not have enough meat for their people. They buy meat from the lands of commercial ranching.

You have read about Denmark as a land of specialized farming. One of its special farm products is bacon. Its packing plants might be called bacon factories, for bacon is the principal product. Most of our bacon is the side meat of a hog, striped fat and lean. In Denmark the hams and shoulders are cured as they are here, but most of the rest of the animal is cured as bacon. Ireland, too, exports bacon and hams.

The poultry industry. We cannot leave the meat industry without a brief look at poultry and fish. If you turn back to the chapter on hunters and fishermen, you will find there all the information you need on processing fish. Perhaps this would be a good time to review it.

Most farmers keep a small flock of chickens. Many have a few ducks and geese. Not many of these birds and their eggs are sold, however. Specialized poultry farmers provide most of the poultry and eggs that are for sale in stores.

Some breeds of chickens are best for egg laying. Others are best for eating. The same poultry farmer does not usually keep both. Most chicken farmers do not keep ducks, geese, or turkeys because these birds need different care and different feeding. All, however, are usually sent to the same poultry-processing plants.

The first step in processing poultry is removing the feathers. There are workers who spend all their time picking chickens. Chickens may be sold just picked, or they may be completely prepared for cooking. Some are frozen. It is possible to buy frozen chicken legs or packages of all white meat or livers or gizzards.

Most poultry farms are near the more densely populated parts of the country. The eastern part of the Middle West, some areas in the East, and a few sections of the Far West produce most of the chickens. The same regions have duck farms, but not nearly so many of them. Texas produces a large share of the turkeys. These big birds need

more space and more feed than chickens. They do not fit so well on the smaller farms of more densely populated areas.

Flour Milling

You have seen how we get dairy products and meat. All you need for a sandwich is the bread. Bread is made from flour. Flour milling is a great industry. It was the first food industry to be taken out of the home and mechanized. In fact, it was the first of all industries to be mechanized. You know the story of primitive milling methods and how they developed.

The raw material. When wheat comes to a large mill, it is stored in huge concrete bins, like big silos. Different kinds of wheat are kept in separate bins. As you learned on pages 96-97, there are many varieties of wheat. They all differ a little in the kind of flour they will make. Spring wheat and winter wheat make flour with different qualities. Even the weather makes a difference in the wheat.

At the mill, experts test the wheat and workmen mix it in just the right proportion to get the different kinds of flour they want. Flour for home baking is not the same as flour for bakeries. Cake flour is not the same as bread flour. Special flours are made for pastries and for crackers and for breakfast cereals. Macaroni and spaghetti are made of flour from just a few varieties of very hard wheat.

A grain of wheat is a seed. A new wheat plant will grow from it. The part that will actually grow is called the germ. It is really a tiny plant tightly folded at one end of the grain. Most of the rest of the grain is made up of a white substance that is largely starch. That is the only part wanted for white flour, but it is covered with several layers of thin brown coatings. The task of the miller is to clean the wheat, remove the brown coverings and the germ, and grind the starchy part of the grain

into powder-fine flour. These jobs are done in a series of operations, most of which are grinding and sifting time after time.

Millers and milling machines. In a meat-packing plant, you see many busy people, because much of the work cannot be mechanized. In a flour mill, you see few people. The work is completely mechanized. From the time wheat comes into the mill until it goes out as flour, no one touches it. A few men are there to turn the machines on and off and see that they run properly. The machines do the work.

To see what happens in a mill, look at the diagram on this page. Wheat enters the mill at *A*. It is lifted to an upper floor on the first elevator, lettered *B*. Without being touched by a workman it slides downward through machine after machine.

D, *F*, and *H* are sifting machines to take out weed seeds. At *G* the wheat goes through a machine with a blower to remove dust. At *I* it is washed. Now it has reached the bottom of the mill and another elevator takes it to the top again. There it is dried by a blower at *J*. At *K* it goes through the first grinding rolls. Such rolls take the place of the old-time millstones. You have probably seen rolls that work in about the same way in an ordinary clothes wringer. Imagine the rolls much larger and made of hard steel. You cannot see the rolls in a mill, for they are boxed in to keep flour dust from filling the air.

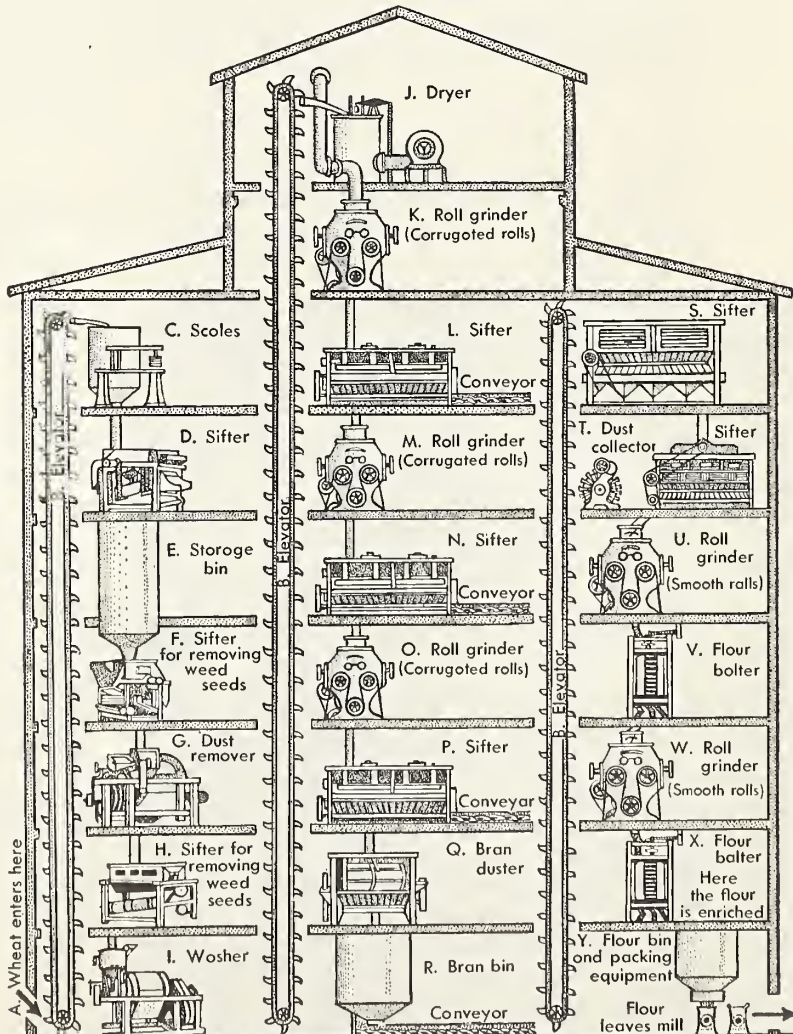
The rolls at *K*, *M*, and *O* break the wheat grain into smaller and smaller pieces and loosen the outer coats, which are called bran. After passing through each pair of rolls the broken grains are sifted. *L*, *N*, and *P* are sifters. Some of the starchy part of the

grain is sifted out at each machine, leaving only bran to drop to the bin at *R*. Most of it will be sold for livestock feed.

The starchy part of the grain goes to the top of the mill again. It is still in small pieces, not ground into flour. At *S* the starchy bits are sifted; at *T* blowers and sifters remove the loose dust. The machines at *U* and *W* grind the material into flour. At *V* and *X* are sifters called bolters. Inside them the flour is sifted through bolting cloth. Bolting cloth is usually made of silk in which the separate threads are twisted hard and tight. When this thread is woven into cloth, there are open meshes between the threads. From the bolter at *X* the flour drops into the bin at *Y*, and from the bin it drops into flour sacks.

Simplified diagram of a flour mill.

Adapted, Courtesy General Mills, Inc.



Grain as food. Wherever wheat is raised, there are flour mills. If you look at the wheat map on page 116, you will see that most of the large wheat regions are regions in which industry is mechanized. In other regions a little wheat is ground by more primitive methods.

Not all the grain in the world is eaten as loaves of bread—not even all the wheat. The people of northern China eat most of their wheat in the form of homemade noodles. Italians do not live entirely on spaghetti, as many people seem to think, but they do eat large quantities of it. Europeans and many other people, as well as Americans, eat noodles, spaghetti, macaroni, pies, crackers, biscuits, cake, pancakes, dumplings, and rolls of many shapes and sizes. Breakfast cereals are used in America much more than in other countries. They are made in many ways. Some are made of whole grain and some of grain with most or all of the husk removed. A few are made from flour.

For most breakfast cereals the grain is steamed to soften it. Salt and perhaps sugar or other seasonings are added. Then the grain may be rolled flat and baked as flakes, squeezed through holes, or puffed. The puffed cereals really are shot from guns. Grains or pieces cut from squeezed-out noodles of dough are put into a cylinder that can be tightly closed. There they are heated under great pressure. A workman quickly opens one end of the “gun.” The bits of cereal shoot out against a screen. Then they slide down to a conveyor that takes them to a packaging machine. Nearly all commercially processed foods are wrapped and packaged by machine.

Wheat is not the only breadstuff in the world. In English-speaking North America most of the bread is made from wheat, but breakfast cereals are made from corn, oats, and rice as well as wheat. More corn bread is used in the South than in the North, but nearly everyone enjoys corn bread for a change. Throughout tropical Latin America, corn is the principal bread grain. Corn

bread is necessarily different from wheat bread, for it cannot be raised with yeast. Instead, baking powder, sour milk and soda, or beaten eggs are used to raise the bread. Tortillas, the common bread of Mexico, are flat cakes, not raised at all. Machinery has been invented for preparing the corn and making tortillas, but most Mexicans still do the work by hand.

Across Europe north of the wheat-growing regions lies the black-bread belt. In this region rye bread is generally used instead of wheat bread. Rye bread is really dark brown, not black. As a bread grain, wheat is usually the first choice where people can grow it or sell other products to buy it. However, there is probably not enough good wheatland in the world to supply all Europeans with wheat, even if they could all afford to buy it. With most Europeans, rye is the second choice. It is the only grain except wheat that can be used for yeast-raised bread. In the black-bread belt the climate is a little too cool and damp for wheat, but rye grows well.

Canning and Freezing

Now we go back a little in time for another basic invention in the food industries. The year was 1795, and France was in the midst of its great revolution. Fighting had been going on for years. The men in the French government at the time knew that the soldiers were not properly fed and offered a large prize to anyone who could invent a better method of preserving food.

Years passed. A young officer in the French army, Napoleon Bonaparte, made himself ruler of France and set out to conquer Europe. The prize offer was still open, but no one claimed it.

All this time a man had been working quietly at his home in a suburb of Paris. His name was Nicolas Appert. Only a few people today know his name, and everyone knows the name of Napoleon. Probably this man who was to give the world a better

and more varied food supply really deserves more fame than the man who tried to conquer the world.

Most people would have become discouraged as the years passed, but Appert kept on with his experiments. In 1809 he was successful. The French government gave him the prize in 1810.

The basic invention. Appert had invented the process of canning food. First he cooked the food. Then he placed it in wide-mouthed glass bottles, corked the bottles tightly, and heated the bottled food again in kettles of boiling water. He had been on the right track for several years, but he did not stop until he was sure of his techniques. He had to design his own bottles and have them made, because the ordinary bottles of his time did not have wide enough necks. He tried various methods of sealing them. To discover the best length of time to cook various foods required long series of experiments. When Appert presented his results to the French government, they were in the form of a book of recipes.

The same techniques worked for anyone who followed the rules carefully, but no one knew what made them work. It was not until many years later that Louis Pasteur, another Frenchman, discovered that bacteria spoil foods. Cooking killed all the bacteria. The second cooking in the bottles killed any more bacteria that might have got in from the air during the bottling.

Experiments and inventions. Although Appert had experimented a long time with his bottles, they were still not entirely satisfactory for commercial canning. They were hard to seal, and they broke easily. Almost at once an English food processor began to experiment with containers made of tin plate. He called the containers cannisters, but soon the word was shortened to can.

In 1817 a young Englishman immigrated to America, planning to start a canning industry here. He understood canning, but

he did not have money enough. He needed someone with the necessary capital to help him. The young man landed in New Orleans, but he could not interest anyone there in the newfangled methods of preserving food. Finally he gave up and walked to Boston. There he found men willing to help and founded the first canning factory in America. The company canned sea foods, tomatoes, and evaporated milk.

Very soon another company in Boston began canning fruit. A company was founded in New York to can fish, lobsters, and oysters. In 1841 a sardine cannery was started in Maine. The salmon-canning industry of the Pacific coast began in the 1850's in Sacramento, California.

Scientists and inventors have made many improvements in the canning industry. Agricultural scientists have developed new varieties of fruit and vegetables that are especially suitable for canning. Scientists hired by canning companies have worked out

Pineapple being graded and packed. The first successful pineapple cannery was established in Hawaii in 1901. Today a cannery can produce in fifteen minutes as much as the first one did in a year.

Courtesy Dole Pineapple Company





Courtesy Birds Eye Frosted Foods

A specially designed machine called a viner separates peas from the pods and rolls them into containers. It can be moved from field to field. These peas were grown near Walla Walla, Washington.

new techniques for new products. Inventors have given the factories better and cheaper cans. Others have designed hundreds of machines for processing food and for filling and sealing the cans.

Canning techniques. Most canning factories are not very large. Even the great fruit- and vegetable-canning companies have many small factories scattered over the farming regions. Each vegetable lasts only through a short season. For example, asparagus is ready for canning in the spring. Peas come a little later. Tomatoes are ripe in the late summer. The canner wants to keep his factory working through the longest possible season, and so he plans to have one vegetable follow another through the summer. If the factory is in an asparagus-growing region, asparagus will be the first crop canned. The grower hurries a day's cutting to the canning factory. There the asparagus is washed. After they have been

washed, the stalks are carried on conveyors past a line of workers, usually women. They sort the stalks. The tenderest go into the best grades. Tougher stalks may be used for soup. Really hard and woody stalks are thrown away. Crooked and short stalks are cut up in pieces for canning.

The long stalks for canning whole are lined up with their tips even and the bases are cut off to make all the stalks the same length—just the right length to fit a can. Asparagus stalks must be put into the cans by hand. Then, on a conveyor, the cans go under a machine that fills each can with water. Next they go under the spouts of another machine that drops a measured quantity of salt into each can.

The tops of the cans are still open. Another machine puts on the lids and bends lid and can together to form an airtight seal. The asparagus is cooked in the cans in huge pressure cookers that look like tightly covered kettles. After the cooking, cans

of asparagus are again placed on a conveyor to go through the labeling machine, which pastes on the paper label.

Processes differ a little for other vegetables and fruits. In harvesting peas for canning, the farmer cuts vines and all. The vines must go through a machine that picks and shells the peas. For sweet corn, there are machines to husk the ears and cut off the grains. Cans are filled by machine, too.

The description does not fit every canning factory, but the processes described are typical of the methods commonly used for fruits and vegetables. If you glance at the grocer's shelves, you will see dozens of other products. For example, there are shelves of many kinds of canned soup. The canners had to bring many ingredients together for those soups. This kind of canning is not usually done in scattered, small canning factories. The cannery is likely to be a large plant located in a specialized truck-farming region. You have read about the canning of sea food and meat in other parts of this book.

Frozen foods. Frozen foods have been mentioned a number of times. Both meat and fish have been frozen for a long while. Growers in the northwestern part of the United States began to experiment with frozen fruits about forty years ago, but the results were not satisfactory. The first of the modern style of frozen foods was offered for sale in 1930. The secret of modern frozen foods is quick freezing. The temperature of the freezing equipment is kept far below zero, so that foods are frozen solid within a



Courtesy H. J. Heinz Company

Vegetable soup in the making. You can identify the vegetables.

few minutes. With quick freezing, the products that are frozen are almost like fresh foods.

Foods are prepared for freezing in much the same way as they are prepared for canning. Products are hurried to the freezing plant, where they are thoroughly washed, inspected, and sorted. They are not cooked,

Putting the last tray of packaged peas into a big froster.

Courtesy Birds Eye Frosted Foods



but go through a process called blanching, which means treatment with steam.

In most freezer plants, the food is packaged before freezing. It is usually wrapped in cellophane and placed in pasteboard cartons. The packages are carried on a conveyor belt to the freezer, where the temperature is many degrees below zero.

In the chapter on fishing, you read about quick-frozen fish fillets. Quick freezing has opened up markets to fishermen who are far from the densely populated areas of the earth. Quick freezing has given fishermen of Iceland, Newfoundland, and Labrador a chance to get their fish to world markets as fresh fish. Factory ships, equipped for freezing their catch, can make long trips, remaining at sea until they have a full load. They do not need to rush back to their home port before the ice melts.

These are a few examples of how freezing has helped both food producers and consumers. The consumer not only has a better selection of food, but gets it washed, trimmed, and ready to cook. Recently, freezing com-

panics have been preparing and selling frozen pies and biscuits ready to bake. Some have even been experimenting with whole meals, ready cooked and needing only to be heated.

Quick freezing also provides farmers with a way of keeping their home-grown foods for use the year round. Almost every country town has a freezing plant. A farmer rents one or more storage compartments, which are called lockers. He brings meat, vegetables, and fruit to the plant. Employees prepare the products and package them. Then they freeze the food and store it in the farmer's locker. Many city people use freezing lockers, too. They may take food from their own gardens or buy food products when they are most abundant.

Flavor and Seasoning

People could live on dairy products, meat, bread, vegetables, and fruit. Long ago our ancestors lived almost entirely on such products. They had no good ways of keeping even these simple products so that they could have variety the year round. Now, as you saw, the food industries have given us year-round variety in these all-important foods. Still we are not satisfied. To quote an old rhyme, we also want "sugar and spice and everything nice."

Many plants contain sugar, but most of the commercial supply comes from two—sugar cane and sugar beets. Sugar cane grows in the tropics. The sugar beet is a middle-latitude plant. It is an important crop plant of the Great Northern Plain of Europe and is grown in many regions in America, especially on irrigated land in the West. The sugar is extracted by cutting the beets into shreds in machines with revolving knives and soaking the shreds in hot water.

Here in a sugar-beet factory the beet pulp is being poured into a vat where the sugar will be removed. Beet shreds have scattered over the floor and machinery.

Library of Congress (Rothstein)



We have many flavoring materials. Candy and ice-cream manufacturers say that chocolate is the flavor liked by the most people. Chocolate, as you know, comes from the seed of a tropical tree. The seeds need only to be cleaned, roasted, and ground. When sugar and other flavors are added and the chocolate is allowed to harden, you have a chocolate bar. Without the flavors, you have a cake of bitter chocolate to be used in making candy, ice cream, or other foods.

Spices, too, go through various kinds of processing. Most of them are at least dried, ground, and packaged. Then there are the products we call condiments, such as prepared mustard and catsup. They are a blend of ingredients from many places. Preparing them keeps many workers busy.

Vegetable oils make up another large group of food products. Salad and cooking oils, margarine, and cooking fats are made from many different vegetable products. In America, cottonseed oil, soybean oil, and oil from the germs of corn are most widely used. Europeans get most of their vegetable oils and fats from peanuts imported from Africa, from copra (dried coconut) imported from many tropical regions, and from various other tropical nuts.

You still do not know the whole story of food processing. In your own community there may be a food industry that has not been mentioned. You have seen at least that the preparation of food is a complex business. Scarcely anything gets to your dinner table without the work of many people.

FARM PRODUCTS INTO TEXTILES

Farmers provide the world with more than food. One-fourth of the farmers in the United States grow cotton on their farms. Millions of farmers in Africa, India, southern China, the Soviet Union, and tropical Latin America grow cotton, too. In practically every country in the world, farmers keep flocks of sheep and clip their wool. Across the Great Northern Plain of Europe, from Ireland far into the Soviet Union, flax for linen is a common farm crop. Hemp, jute, and other fiber crops are less widely grown but are important in their own regions. In eastern Asia and parts of southern Europe, farmers add to their income by raising silkworms. Even nomadic herdsmen have wool, mohair, and camel's hair for sale. Farmers on the plateaus of the Andes clip the soft wool of their llamas and alpacas.

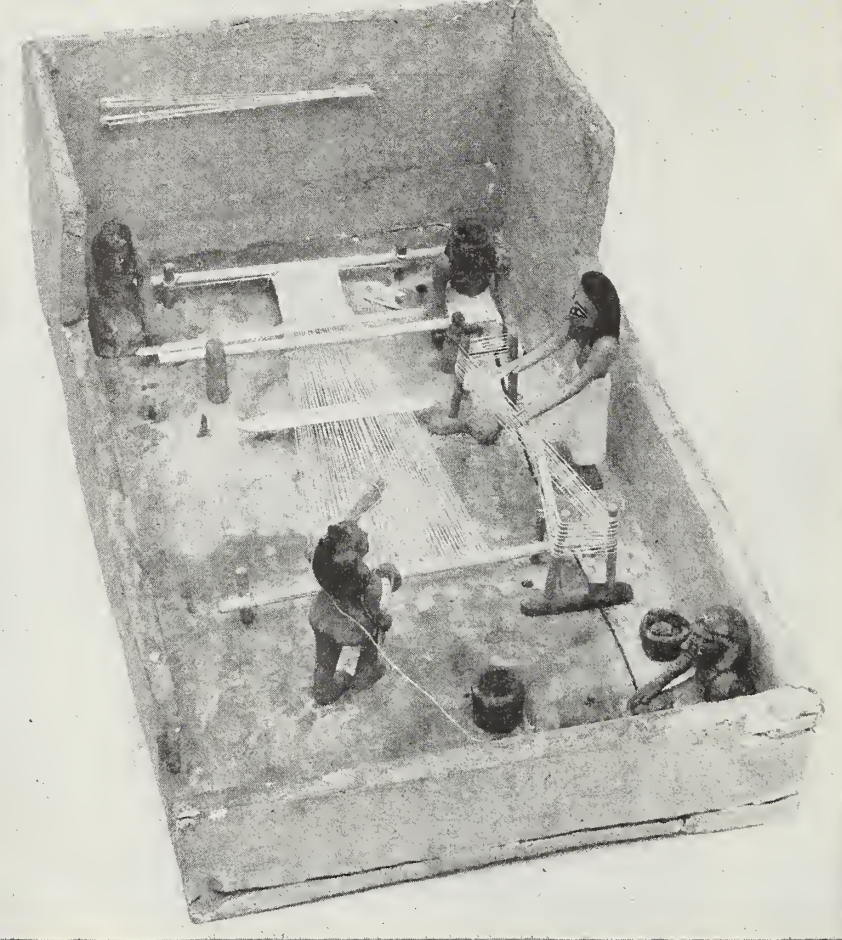
From Fingers to Machines

Weaving was one of the many inventions made near the beginning of the New Stone Age. Weaving is simpler than spinning and probably came first. The principle

of weaving seems to have been used first in making baskets from grass. Spinning is a more difficult process. We do not know who invented it or where it was invented. We do know that well-made cloth, woolen and linen, was part of the New Stone Age culture in most of the world.

From the New Stone Age down to about two hundred years ago, spinning was one of the most burdensome jobs of the housewife. Among some of the most primitive peoples of the earth, the work is still done by the women at home. Travelers say that the women spend all their spare time spinning. They spin while they visit with the neighbors and while they walk along the road.

You will understand the spinning process best if you try it for yourself. A small bunch of cotton will do as raw material. Your job is to draw out a few fibers, without tearing them loose from the rest of the bunch, and twist them so hard that they will stay twisted. Then pull gently on the yarn you have made until you have drawn a few more fibers from the bunch. Twist again, and then draw out more fibers, as long as



Courtesy of the Metropolitan Museum of Art

About 2000 B.C. an Egyptian had this model of a weaving shop placed in his tomb. It is so exact that you could learn ancient methods of weaving from it.

your patience lasts. It can be done with only the fingers for tools, but you will probably not succeed the first time you try.

Now you have the two essential processes of spinning—drawing out fibers so that they extend in the same direction and twisting them together. You can make a continuous thread or yarn because the fibers overlap and cling together.

Ancient spinning and weaving. When scientists first began to dig up articles left by people of the New Stone Age, they were puzzled by many doughnut-shaped pieces of stone and pottery. Little by little they pieced the evidence together and decided that the objects were weights used in spinning. The scientists called them spindle

whorls. A spindle is a round stick on which thread or yarn is wound after it is spun. The hole in the spindle whorl fitted over the spindle. It held the end of the finished yarn that had already been wound on the spindle so that it could neither unwind nor untwist. The spinner's hands were free to draw out another length of fibers. Then the spinner gave the new length of yarn a sharp twirl with her fingers. The twirl set the spindle and spindle whorl to spinning like a top. The spinning motion twisted the yarn much tighter and more smoothly than it can be done by hand.

The picture shows how weaving was done in very early times. It is a photograph of small wooden models of women weaving. The models were made in ancient Egypt. The loom is a wooden frame with threads fastened on it lengthwise. These are called the warp threads. The weavers worked the crosswise threads, called weft threads, or some-

times wool threads, back and forth, over and under the warp threads.

Textiles in medieval Europe. Throughout the Middle Ages the people of Europe dressed mainly in wool. Those who could afford it also had clothing made of linen. In eastern Asia rich people used silk, and a little of the gleaming fiber found its way to Europe. About the year 1000, silkworms were introduced in Italy. Cotton was rare in Europe until the Americas were settled, but even then it was more costly than silk.

Simple machines had been invented for spinning. The first of these spinning wheels was turned by hand. Later a foot treadle was added. Then the spinner had both hands free and could work faster.

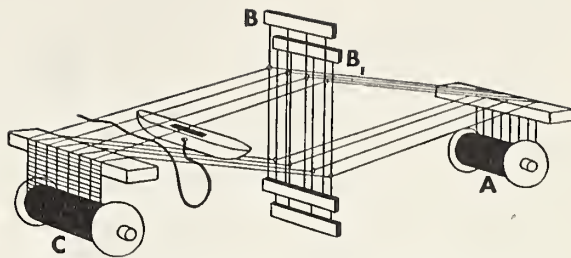
Looms had been improved since ancient times. The weaver no longer had to weave the weft yarn (the crosswise threads) back and forth with his fingers. The loom had attachments called harness, made up of frames. The frames had openings through which the warp yarns could be threaded.

The drawing shows how the frames worked for the simplest weave. Every other warp yarn was threaded through one frame, and the alternate yarns through the second frame. The weaver raised one frame. Half the warp yarns came up with it. Thus the warp yarns were separated. While they were held apart, the weaver threw between them a shuttle carrying a strand of weft yarn. Then he reversed the frames and threw the shuttle back. Later treadles were added to raise and lower the frames.

The Industrial Revolution. In the year 1733 an Englishman named John Kay invented the “flying shuttle.” By jerking a string held in his hand, the weaver could make the shuttle go shooting between the separated warp threads to the other side of the loom, carrying the weft thread with it. The shuttle was a boat-shaped piece of wood, with the yarn wound on a bobbin inside. When the warp threads were separated, the lower ones rested on a wooden beam. The shuttle coasted across on top of them.

Kay’s shuttle does not seem like a very big invention, but it is usually called the beginning of the Industrial Revolution. Kay’s flying shuttle was the first of a long series of inventions that led to the mechanization of the world’s industries.

With the flying shuttle, a weaver could work four times as fast as he did before, and the spinners could not keep the weavers supplied with yarn. In 1738 an inventor made a machine called a spinning frame. It kept six spindles whirling instead of one. In 1767 James Hargreaves invented a machine which he called a spinning jenny. The spinning jenny mechanized and speeded up still more of the work.



A diagram to show how yarns are separated on a hand loom. The yarn is unrolled from the warp beam, *A*. By looking carefully, you can see that every other yarn is threaded through the top frame, *B*, and the alternate one through the bottom one, *B*₁. While the yarns are separated, the weaver throws the shuttle between them, carrying the weft yarn. The cloth is wound on the cloth beam, *C*.

In 1769 Richard Arkwright invented a machine that mechanized another process. Before cotton is spun, it must be carded. Carded cotton is in a roll like a soft rope. The fibers are partially straightened out, but they are not twisted together. They are like the fibers you pulled from the bunch of cotton before you began to twist them, except that the rope is larger and more even.

This rope of cotton—if you want the name, it is sliver, which rhymes with driver—must be pulled out and twisted. Arkwright’s most important contribution was a mechanical means of drawing out the sliver. In his machine, the sliver went through several pairs of rolls. The two rolls in each pair fitted together tightly enough to give them a firm grip on the cotton. Each pair ran a little faster than the pair before. Thus each pair of rolls pulled just a little faster than the cotton could go through the preceding rolls. If the difference was too great, the sliver would break. When it was just right, the separate fibers would slide past one another just a little. The sliver would come out longer and thinner, but unbroken.

Then in 1779 Samuel Crompton invented the spinning mule. It made spinning entirely automatic. An *automatic* machine is one that works by itself. The spinning mule drew out the cotton fibers and twisted them into a thread without anyone’s having to pull a lever or press a pedal.

The mule greatly increased the speed of spinning. Now more yarn could be spun than the weavers could weave. Water power was already in use for spinning. In 1785 the first power looms were used. The principle of the loom was not changed, but it was made to work by means of water power instead of the hand-and-foot power of the weaver. Four years later the use of steam began in the textile industries.

With power spinning machines making yarn and power looms weaving the cloth, cotton materials became more abundant and cheaper than they had ever been. Still the problems of the industry were not entirely solved. The next difficulty was the cotton supply. If you live in a cotton-growing region, you know all about a cotton boll. You can skip the next paragraph.

You have seen pictures of cotton plants and cotton bolls in your earlier study of geography. The fluffy mass of fibers looks soft, but it really has many large, hard seeds inside. Each fiber of cotton is firmly attached to one of these seeds.

The plantation owners of the southern United States had raised a little cotton from early colonial times, but cotton growing did not pay very well. In a whole day, a worker could get the seeds out of just one pound of cotton. Then, in 1792, a young man from Connecticut took a job teaching school in Georgia. His name was Eli Whitney. He was known to be skillful with tools, and some of the neighboring plantation owners asked him to make a machine that would take the seeds out of cotton. In 1793 Whitney succeeded. He invented the cotton gin.

Whitney's gin was simple. Inside a box he placed metal strips. There were narrow spaces between them. Many flat circles of metal with saw-toothed edges were fastened to a roll which could be turned by a crank. The circular saws turned in the spaces between the strips of metal. They caught the cotton fiber and dragged it through the spaces, but, since the seeds were too large to go through, they were left behind.

When this machine had been slightly improved, one man could take the seeds out of 300 pounds of cotton in a day. Thus, it enabled a man to do 300 times as much work as he could do without it. Now it paid to raise cotton in the South. More than anything else, the invention of the cotton gin led to the rapid settlement of the South. Settlers moved into the region suitable for cotton growing as fast as arrangements could be made to move the Indians off the land.

The invention of textile machines was the real beginning of the change from handicrafts to mechanized industry. Once people had the idea of using machines, machines were invented for other work also, until almost every industry was mechanized. Therefore the invention of those first machines is called the beginning of the Industrial Revolution. From its beginning in England, the Industrial Revolution spread quickly to the continent of Europe and to America. It reached other regions more slowly.

Even yet the Industrial Revolution has not reached the whole world. In some places practically all industry is mechanized. In other regions most work is still done by hand. But even such areas do have a few factories with modern machines if there are any products to process. You would find them among the peasant farmers of China, India, and Africa, side by side with the simpler handicraft industries.

Modern Textile Mills

If you have forgotten how and where cotton is grown at present, turn back to pages 89-92 and read about it again. There you read how the cotton fiber is picked, ginned, and baled.

From the gin, the bales are sent to warehouses. There they are graded. The graders pull handfuls of cotton from a bale. By look and feel they match the cotton with samples that have been furnished by the government. They consider how clean the cotton is, length of the fibers, and color.

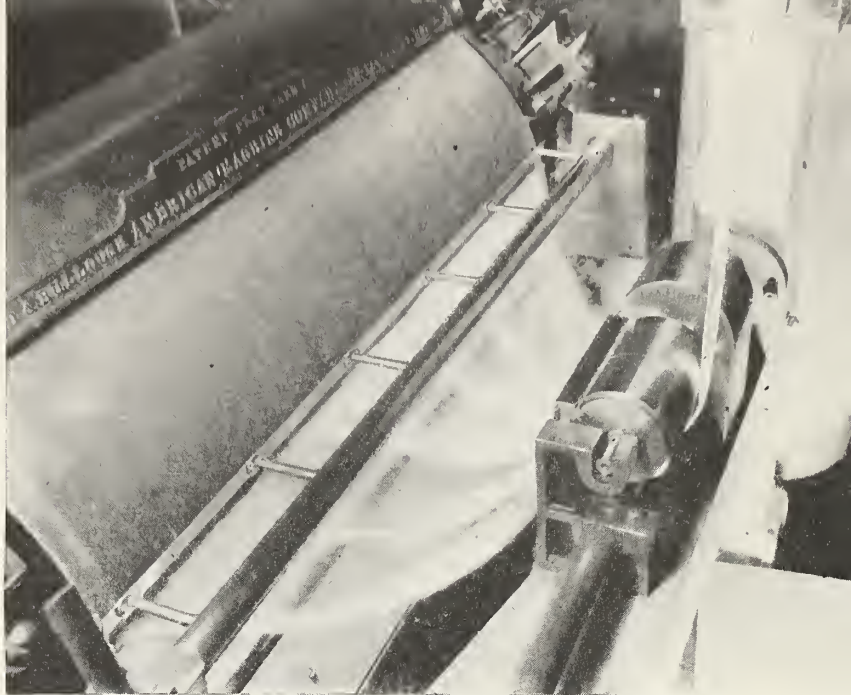
The buyers for a cotton mill order cotton by grade. The grades that they buy depend upon the use they intend to make of the cotton. The manufacturer of fine sheets, for example, needs a better grade than does the manufacturer of grain sacks.

The beginning of yarn. When the cotton reaches the mill, workers open a number of bales at once. They throw armfuls of cotton from one bale and then another into a machine that separates and fluffs the fibers. Then the fibers go to another machine that beats out still more dirt. The fibers come off this machine in a thick blanket that is automatically rolled around a rod.

The blanket of fibers is next fed into a carding machine. This machine has a large roll covered with wire brushes. The brushes pick up the fibers in a thin layer. Other brushes comb out short fibers and any trash that may be left. The picture shows how the cotton leaves the machine. It is a film of fibers that looks like a spider web. This thin film of fibers runs through a round opening and comes out in a soft rope—the sliver which you read about earlier.

The slivers are drawn out between rolls such as Arkwright invented. Several strands are put together, and then they are drawn again. This sliver is the real beginning of yarn for weaving. The next machine draws the sliver thinner and gives it a slight twist. It comes out about the size of ordinary twine for tying packages, but you can easily pull it apart with your fingers.

Spinning. Now at last the cotton is ready for the spinning machine. On the spinning machine the yarn is drawn still more and twisted tightly. One pound of cotton can be drawn out to make a thread 170 miles long, but very little is made even half that fine.



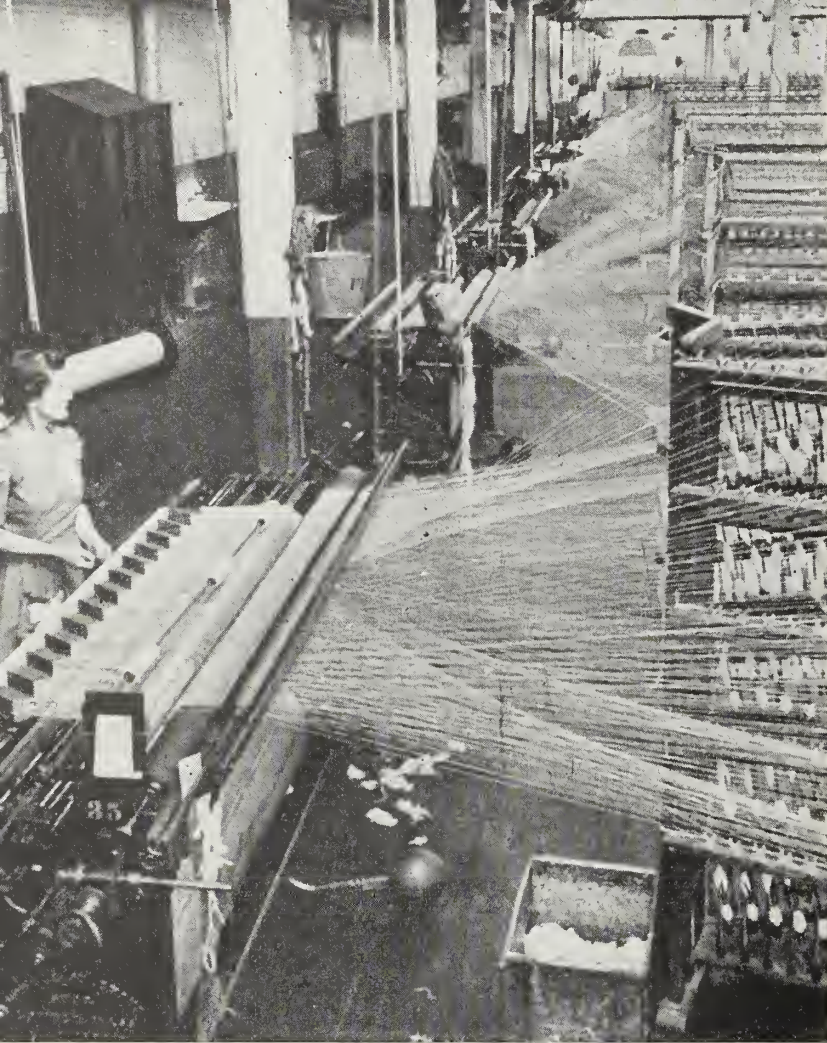
Courtesy Pepperell Manufacturing Company

In the center of the picture a film of cotton fibers is coming off the wire brushes of a carding machine. At the right it passes through the part of the machine that forms it into sliver.

When it is finished, the machine automatically winds it on spindles. Of course you do not understand how all this is done. The only way you could understand it would be to spend a long time in a cotton mill.

The description has talked about the making of one strand of yarn. As you look down the length of a spinning room, you see long rows of thousands of spindles whirling at once. A mill with only 25,000 spindles is considered small. To be called large, it must have more than 60,000. Compared to the number of whirling spindles, there are few workers. Most of the time the workers just stand and watch the machines work. One worker can watch two machines, each with a long row of spindles. Now and then a yarn breaks, usually where it leaves the last pair of drawing rolls. The worker touches the broken ends together, and they twist into a yarn again.

No, you are not expected to understand just how yarn is made. The machines have been described so that you can see some of the effects of mechanization. Think of the thread you spun with your fingers. Think of the woman walking along a country road,



Courtesy Botany Woolen Mills

Preparing warp for weaving. Yarns come from the creels at the right and are laid parallel by the warping machines. A filled beam lies on the floor beyond the woman's head. The beams on the machines are underneath where you cannot see them.

carrying a bunch of fibers, drawing out a few at a time, twisting them by whirling a weighted spindle, loosening the whorl, winding on the thread, replacing the whorl, and then starting all over again.

No machine can do that. For any work to be mechanized, it must be broken down into separate, simple jobs. Machine parts are designed to do one job, and they go on doing that one job as long as the machine is running. Sometimes material is passed on from one part of a machine to another, and the different parts do different jobs. But still each set of parts does just one job. The automatic machine that passes the work on

from part to part is really several machines built into one. In hand industries division of labor is helpful, but in mechanized industries it is absolutely necessary.

Making cloth. For weaving, yarn is wound on bobbins for the weft and on tubes for the warp. The tubes wound with yarn are set up on racks called creels. Yarns from the creel are threaded through the guides of a warping machine. It winds the material onto a huge spool, called a beam. All the yarns are wound on exactly parallel, as they will be in the warp of the finished cloth.

When the yarns are all white, they look like a snowstorm as they seem to fly through the air from the creel to the warping machine. There are hundreds of them, as many as there will be lengthwise threads in the finished cloth. If the material is to be striped lengthwise, some of the yarns will be colored. The yarns are wound on the beam so that every stripe is in place.

When the beam is filled, it is taken off the warping machine, but the yarn is not yet ready for weaving. First it must be sized. The yarns are run off the beam, through a bath of starch and other materials, and over a hot roll that dries them. The sizing keeps them from being damaged in the loom. Then, still parallel, they are wound on another beam. This beam is ready for the loom.

Harnessing the loom is a tedious hand job. It requires great skill and care. The picture on page 231 shows how it is done. The frames with strips of metal hanging down are the harness. The worker must thread an end of yarn through an eyelet in each strip. The frames move up and down, separating the thread in various ways according

to the weave. Once the loom has been harnessed and set in motion, it raises and lowers the correct frames automatically at exactly the right moment for the shuttle to shoot through between the separated yarns.

On all but the simplest looms there are several shuttles, one above the other. The loom raises and lowers the frame that holds the shuttles, so that the right one is in line and ready to go when its turn comes. You can see why there must be more than one shuttle if the machine is weaving material with crosswise stripes, for example. Different shuttles are necessary to carry the different colors of yarn.

Of course, for woven colors, the yarn must be dyed. Most colored cottons, however, are dyed after weaving. A great many cotton materials are never dyed at all. They are used white. Whether or not they are to be dyed, nearly all cottons are bleached. This bleaching is done by the use of chem-

icals that take out the brownish color and leave the material pure white.

Dyeing, too, is a chemical process. It is very complicated and must be controlled by chemists. Solid-color materials are boiled in vats, with dyes and other chemicals. The dyes must soak into the fibers and form chemical compounds that will not wash out and not be easily faded by sunlight. Many cotton materials are called prints. As the name suggests, dyes are printed on the material.

We have left out one set of workers so far, because they were busy long before the cotton reached the mill. They are the people who plan the designs. First, artists draw the design. They must know textiles and what can be done with them.

After the artists have drawn a design, technicians must make exact plans for producing it. If the design is to be woven in, they must tell the workers just how many

Harnessing a loom. The woman worker at the front of the picture is drawing warp threads through the small openings in the strips of metal that hang from frames. The strips of metal are loose. The worker slides them along the frame so that she can reach those at the back. She works quickly and skillfully with a special tool made for the purpose. You can see one end of the great loom beam with the yarn coming from it. The yarns look stiff because of the sizing in them.

Courtesy Cluett, Peabody & Co., Inc.



warp yarns of each color are to be laid on the beam in the warping machine and how the yarns are to be arranged. They must also furnish an exact plan for harnessing the loom and for arranging the shuttles. If the pattern is to be printed, laboratory workers must specify exactly what dyes are to be used and how they are to be applied.

Cotton has a great many uses. In the United States about 40 percent of the cotton materials made goes into clothing. About 20 percent is made into sheets, pillowcases, bedspreads, curtains, towels, and other household articles. The other 40 percent goes into industrial uses. The following list names just a few: bags for cement, flour, sugar, and grain; tire fabric; book covers; ropes; canvas for tents and sails; conveyor belts; filters; candlewicks; cord for tying packages; insulation on electric wires; bandages; typewriter ribbons; parachute harnesses; tennis nets; fishing nets.

Woolen and worsted industries. Wool is the second most important textile fiber in the world. We need not go over the whole story of manufacture again, for many of the processes are the same as the processes in cotton manufacture. The following paragraphs explain some of the differences.

Wool comes to the mill clinging together in fleeces, as it was clipped off the sheep. Some fleeces have long wool and some short. Some have coarse wool and some fine. The first job is sorting by experts.

Sheep look very pretty in pictures, but they are not clean animals. Dust and dirt of all kinds collect in the thick wool. To make it worse, the wool is very oily. The oil comes out of the sheep's skin. The oil is thought to be a protection to the skin, but it makes much more dirt stick to the wool. Along with the dirt and oil, the wool is full of all kinds of prickles and burs from plants, bits of leaves, dead sticks, hooked seeds such as nettles have, pieces of straw—in fact, any kind of vegetable material that can break off a plant.

After sorting, the first step in processing wool is a thorough washing—scouring, it is called in the industry. The wool goes into vats in which paddles and beaters stir it around in a soap solution. Mechanical fingers pick it up and drop it onto conveyors which carry it to clean solutions. It is run through rolls, splashed, stirred, and rinsed. Finally it is dried. When it came in, it was brown, matted, and oily. Now it is a fluff of snowy whiteness.

Nothing could look more useless than the soapy water that is filled with all this dirt. It looks like something to send down the drain fast, but it really contains a valuable by-product. From the scouring machine it flows away in pipes to a plant in which this product is removed. The valuable product is the oil that was in the wool. It is lanolin, used as the base for many face creams, soaps, and lotions. Because of this oil, many woolen mills produce cosmetics as a side line.

There are two branches of the woolen industry. Products are either woolens or worsteds. Woolens have a fuzzy surface. Blankets are the most extreme example. Worsted yarns are spun from longer fibers, and they are twisted more tightly in spinning. In a piece of worsted material you can see the separate yarns. In woolen materials you cannot see them clearly, if at all, because of the fuzzy nap that covers them.

In finishing, woolens and worsteds go through a process not necessary in cotton materials. This process is called fulling. It is intended to shrink the cloth and bring the yarns closer together. The material is soaked in warm, soapy water and crammed into a machine that beats it, tumbles it, and squeezes it between rollers.

It is then stretched and dried. If the material is woolen, with a fuzzy nap, this nap is raised during the finishing. Long ago teasels were used. A teasel is a large bur with hooked spines on it. Now the cloth is usually passed under wire brushes set just close enough to pick out some of the

fibers and bring them to the surface. For some fine woolens, real teasels are still used instead of the wire brushes.

Woolens and worsteds may be dyed at any one of three points in their manufacture. Wool may be dyed before spinning, yarn may be dyed, or the finished cloth may be dyed.

A world industry. Most wool is clipped from sheep, but not all of it. The fine wool called cashmere comes from goats raised in central Asia. Llama, alpaca, guanaco, and vicuña wool all come from animals that live only in South America. Angora wool is the fur of Angora rabbits, grown mainly in northwestern Europe. Camel's hair comes from the two-humped Bactrian camel of Asia. Most of these wools are finer and softer than sheep's wool.

There are other fibers. Hemp, jute, abacá, henequen, and ramie are some that are used for special purposes. Linen and silk are widely used, though they are not so common as cotton and wool. There is not room to tell you about all these fibers.

All over the world people manufacture textiles. A few still work by the crudest hand methods. Others have some of the simpler machines. The great bulk of the world's textiles, however, are made in a few countries, and they are made with the kind of machines described here.

Western Europe is the leading textile-manufacturing region. In Britain, France,



Courtesy French Press and Information Service

A Frenchwoman operating a machine which is combing wool in a textile plant of northern France.

Belgium, Switzerland, and Italy, textiles are manufactured for home use and for export. Probably you can find textiles from every one of these countries on sale in your own community. Very often a region specializes in a particular textile or type of cloth that may not be made anywhere else. Or one region may be famous for the quality of a particular product. Irish linen, Scotch tweeds, and French silks are some of these specialties that have become famous.

RAW MATERIALS FROM THE FOREST

Wood is a very old raw material. It has always been easy to acquire and easy to work with. Even stone axes could be used to chop down trees. Many people of the New Stone Age lived in log houses. Some had learned to split logs into planks with wedges, and many could hollow out a log to make a dug-out canoe. After metal came into use, woodworking tools were among the first inventions. The Egyptians and other ancient

woodworkers got excellent results with axes, adzes, and saws of bronze. An adze is like an ax with the blade turned crosswise.

Timber and Boards

Methods of woodworking remained the same for centuries. The workmen did excellent work, but it was slow. One by one better tools were invented, but they were still

hand tools. By the Middle Ages, boards were sawed over a saw pit. Workmen first squared a log with an ax or adze. Then they placed it over a pit. One man stood in the pit and one on the squared timber. They pulled a long saw back and forth, cutting a board the length of the log.

Medieval woodworkers had an assortment of cutting tools, including chisels and sharp knives of many shapes and sizes. The medieval workmen also had augers for boring holes. An auger works like a screw. As it is screwed into the wood, it cuts out small chips and leaves a circular hole. Lathes, too, were used in the late Middle Ages. In a lathe a piece of material is held by its ends and rotated. In early lathes, the workman made the piece of wood rotate by turning a crank on the machine. He held a sharp tool firmly against the wood. As the piece of wood rotated, the cutting tool whittled it away evenly all around.

When America was settled, there were already sawmills run by water power. In the first power sawmills, saws that worked up and down were geared to shafts which were driven by water wheels.

Later, circular saws were invented. They are flat disks of steel with teeth on the edge. Still later, band saws came into use. A band saw is a band of flexible steel with saw teeth on one or both edges. It runs over wheels at the top and bottom. Power is used to turn the upper wheel. Then the band saw runs round and round very fast.

A sawmill. The following description tells how the saws are used in a modern sawmill. It is a description of a real mill. Details differ in other mills, but the machines perform the same tasks.

Logs come to the mill by truck and are rolled off into a log pond. A workman pulls a floating log to the end of a conveyor and attaches a chain to it. The conveyor carries the log into the mill and rolls it off onto the floor. Then the head sawyer decides how it is to be cut. No two logs are

just alike. Some are irregular and lumpy. Some are partly damaged by insects or decay. Some are crooked or splintered. The success of the mill depends upon the head sawyer's good judgment. He must get the most lumber possible out of the log.

The sawyer stands on a platform on a big, noisy machine. He has a row of levers in front of him. By moving the levers he makes arms on the machine reach out and pick up the log, turning it into the position he wants. With a thud that shakes the building, the machine drops the log onto a moving platform called a carriage. The carriage takes the log up to a big circular saw. There is a sound like the buzzing of millions of bees as the saw rips a slab off one side of the log.

The carriage slides back and the sawyer works his levers again. Again the arms of the machine pick up the log and turn it over. Again it goes past the saw, and a slab is ripped off a second side. This happens twice more, and the log becomes a square piece of timber.

The timber goes on, carried on a conveyor to the carriage of another saw. Here it is sliced up into boards or heavy planks. After each time the carriage passes the saw, the machinery moves the timber over just enough so that the next cut will slice off another board of the same thickness.

The newly cut lumber is carried on another conveyor to the trimmers. These men work with smaller saws—band saws in the mill described. A trimmer cuts off any bark edges or splintered ends that may be left on the board. If there is a knothole so large as to spoil the board, he cuts it out, making two shorter boards.

Finishing the lumber. As it comes from the sawmill, lumber is still very rough. Before it is ready for use, it goes to a planing mill. In the planing mill workmen with band saws cut the timbers into standard sizes and shapes for building material. Pieces are cut into the proper form for moldings and other special uses. Sometimes

lumber is put together to make complete parts of houses, such as window frames.

Lumber must be dried before it is ready to use. If it is stacked for a long time, it will dry (season) in the air, but people are not patient enough to wait. Most lumber is kiln dried. It is stacked in a tightly closed room, and warm air is blown through the stacks. To make well-seasoned lumber, the operator of the kiln must watch temperature and time very closely.

Not all boards are carefully finished. One of the largest uses of lumber at present is for packing and crating articles that are to be shipped. For this purpose the lumber does not need to be carefully finished. Much rough timber is used in mines also.

Telegraph and telephone lines and electric power lines are usually carried on tall poles. The poles are the trunks of tall, straight, slender trees. Sometimes they are not processed at all, except by trimming and peeling. Often, though, the poles are creosoted, at least at the lower end. Creosote is a liquid made from tar. Wood soaked in it does not decay quickly and is not eaten by insects.

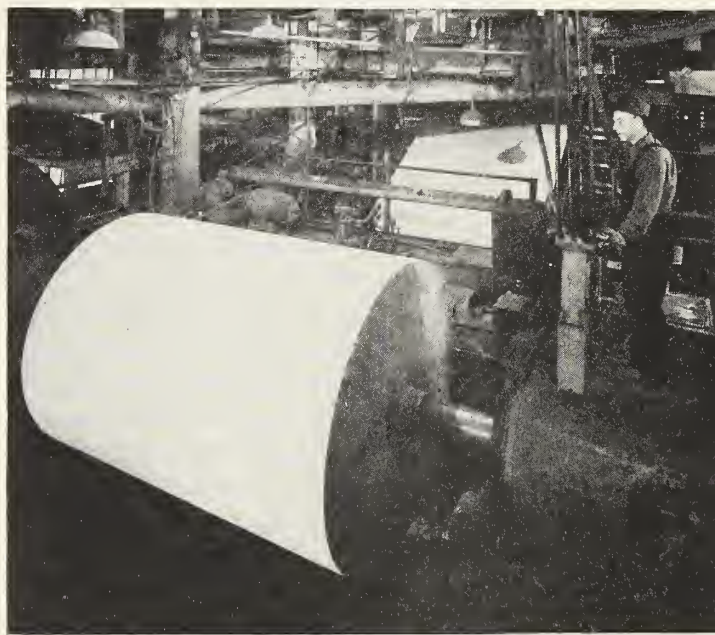
One of the largest uses of wood is for railroad ties. Nothing but long, heavy blocks of wood has ever been found entirely satisfactory for this purpose. Nearly all railroad ties are creosoted to preserve them for a long time.

Veneer. The making of veneer and plywood is a large branch of the lumber industry. Veneer is a very thin slice of wood. Fifty years ago the purpose of veneer was to make cheap furniture look expensive. A table top might be made of the cheapest pine. Glued to the pine was a thin slice of mahogany, walnut, or other beautiful but costly wood. People spoke of solid mahogany or walnut as a sign of quality. In those days veneer meant a cheap and shoddy material. Today the principal use of veneer is for making plywood. It is not used for beauty, but for other qualities, as you shall see.

Peeling a log. The pictures show the most important machine in a plywood mill. The round object is not a roll of paper, as you might think, but a log. The great machine holds the log by its ends and rotates it rapidly. A huge knife is set so that it will peel off a thin layer as the log whirls

In the upper picture a ribbon of veneer is being peeled from a section of log. You can see the veneer much better in the lower picture, where it is coming toward you, away from the machine.

*Douglas Fir Plywood Association, Courtesy
American Forest Products Industries*



in the machine. You cannot see the knife because it is hidden by the log.

The man at the right in the lower picture is perhaps the most important worker in the mill. The wood comes toward him on a conveyor made up of a series of rolls. As they turn, they carry the thin strip of wood away from the machine. At the left in the lower picture, the veneer runs off the end of one conveyor and onto another.

The frame at the left holds the ends of a series of conveyors, one above another. The veneer is now running onto one of the lower levels, but the workman can raise or lower the section of conveyor in front of him. He touches a lever. With a great, grinding crash the end of the conveyor rises and lifts the ribbon of veneer to a higher level. The arrangement is a device for sorting the veneer. This is how it works.

During the first few turns of the log, worthless bark and knots are peeled off. They go on one conveyor to a scrap pile. Then pieces of good material come along, worth saving. The workman may have to change conveyors several times for different qualities before the log is peeled to a perfect round. Then veneer begins coming off the peeling machine in the long, even strip you see in the picture. The workman still must watch carefully, though. There might be cracks, decayed spots, or other imperfections. When these come along, he must change conveyors again.

Sandwiches of wood. The conveyors carry the wood into another room, where it is made into sandwiches. Of course that is not what the workmen call their product. They call it plywood. Most plywood is made of three layers of wood, and that is why the boards are often compared to sandwiches. In the two outer layers the board runs lengthwise of the grain of the wood. The inside layer—the filling of the sandwich—runs across the grain. Special kinds of glue are spread between the layers. Then the workmen stack the wooden sandwiches in

hot, powerful presses. The presses squeeze the layers together until the glue has set. Sometimes boards are made with five, seven, or even more layers; instead of three.

If you know much about wood, you can guess the reason for having the grain run both ways in the plywood. Wood splits easily with the grain but is very strong across the grain. Since the grain runs both ways in a plywood board, the board does not split.

The strength of plywood is in the glue. Tests have been made with machines strong enough to tear the plywood apart. It comes apart through the wood itself, not through the glue. Plywood suddenly became much more useful when waterproof glues were invented shortly before World War II.

Plywood made with waterproof glue is pressed into shape for parts of small boats. There are also plywood airplanes, with wings and fuselages forced into shape in hot presses. Because of its lightness and strength, specially formed plywood is sometimes used for the roofs of buildings that must have very large rooms without supports inside. Plywood also has many everyday uses in houses and stores.

For some purposes, resistance to splitting is not very important. Then boards may be built with the layers all running in the same direction. These are called laminated wood. Both terms really mean the same thing—wood in layers—but in use they have come to have a different meaning.

With plywood we end the story of products made from wood by cutting and shaping. Wherever in the world you find lumbering, you find sawmills. Turn back to the chapter on forests to find out where the lumbering regions are. Plywood mills, too, are found in many places outside North America.

Paper Is Made of Wood

Our old friends at the eastern end of the Mediterranean invented writing more than five thousand years ago, but for four thousand years there was no plentiful material to write

on. As writing material, people have used clay, waxed wood, stone, and specially treated leather called parchment. The ancient Egyptians made a kind of paper called papyrus by pounding together layers of pith from a reed that grew along the Nile.

Our kind of paper was invented in China a long time ago. The Chinese think the date was 104 A.D. There was little travel or trade in those days, and Europeans knew nothing about the invention. It did not reach Europe until the thirteenth century.

Paper is essentially a thin sheet made up of short fibers tangled together. The early European papermakers got their fibers from rags—usually linen rags. The rags were chopped up in small pieces. The pieces were then stirred and pounded and beaten in water until each tiny fiber was separate.

In a large vat the mixture of fibers and water looked like thin mud. The papermaker's most essential tool was a screen. It was a shallow tray with a bottom made of woven wires. The workman dipped his screen into the slush of fibers and picked up just enough. How much was just enough he had to learn by experience. While the water drained away between the wires, he shook the screen to spread the fibers over it evenly. Left on the screen was a sheet of fibers that would be a sheet of paper when it had been dried and pressed.

Wood pulp. Some of our finest paper is still made from rags, but, as you know, most paper is now made of wood pulp. The first pulping machine was invented in 1840 by a German. His machine was merely a grinder, removing nothing from the wood. Pulp which is merely ground wood is called *mechanical* wood pulp. Any operation that merely changes the form of a material is a mechanical process. Cutting and grinding are mechanical processes. Mechanical wood pulp is still made. The end of a log is held against a stone grinder until the log is ground to powder. After it has been ground, the wood is in very small particles, but it is still

wood. Paper that is made from it soon darkens and loses its strength.

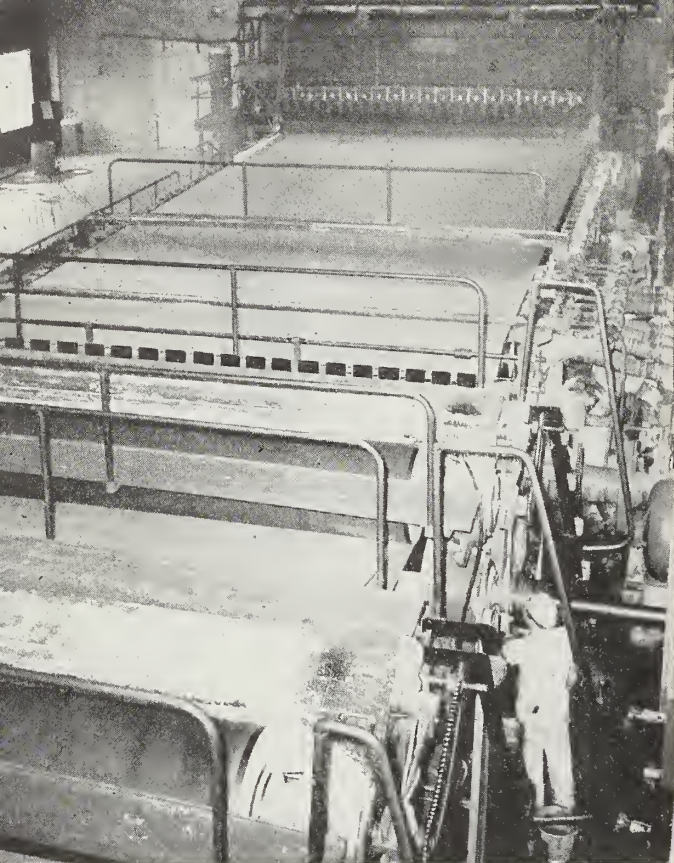
Most paper today is made from chemical pulp. This means that unwanted materials are removed by chemical processes. The first method of making chemical pulp was invented in 1852 by an Englishman.

A modern paper mill is a very large plant. The principal raw material that comes to the mill is logs. Besides a supply of wood, the principal needs of a pulp mill are plenty of power and plenty of water. One paper mill produces 300,000 pounds of paper a day and 140,000 pounds of pulp to be sold to manufacturers of other wood-pulp products. The mill uses 7,000,000 gallons of water a day. You read about power in the paper industry on page 199.

Details differ, but this is how the work is done in one large paper mill in the northwestern part of the United States. Logs reach the mill just as they might go to a lumber mill, with the bark still on. They are sawed into short lengths and the pieces are carried on a conveyor to a huge trough filled with whirling, swishing water. A machine operator stands on a small platform, looking down into the wild, crashing tumble of log sections and powerful streams of water. The tumbling scrapes off the bark. The water washes away all pieces of bark, loose particles of wood, and dirt.

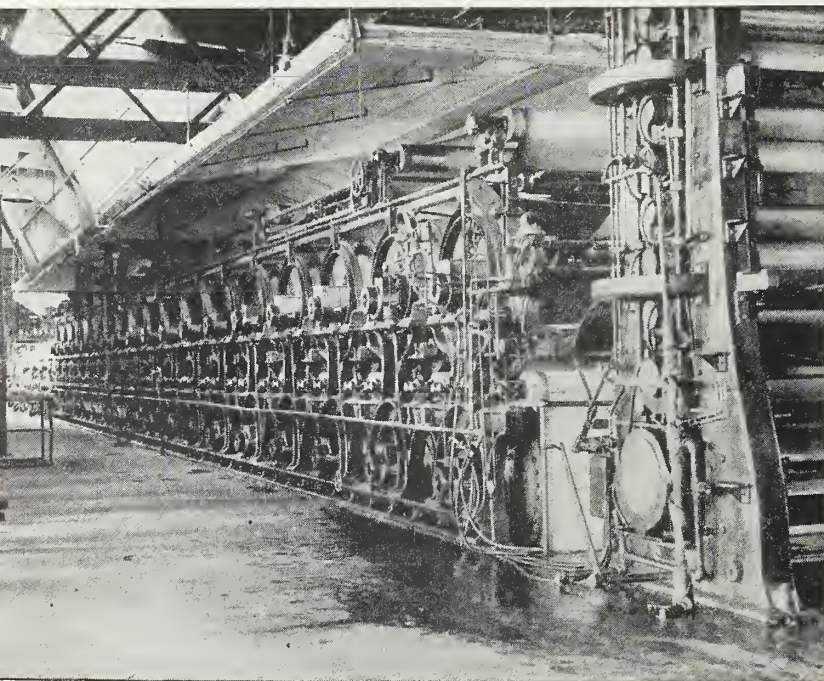
From this huge, deafeningly noisy washing machine the log sections go to the chippers. Inside these machines, whirling knives cut the wood into small chips. Conveyors carry the chips to gigantic kettles. Inside each kettle the chips are "cooked" by hot steam under pressure. They are also soaked in a chemical solution. In the heat and pressure, the chemicals dissolve away all the wood substances except cellulose. All plants have this material. At present, however, wood is the cheapest and most abundant source, and so most pulp is wood pulp.

When the chips come from the kettles they still look like chips, except that they are gray—the color of unpainted wood that has



Meisel from Monkmeier

Beyond the dotted line in the upper picture is the pulp-covered wire screen of a paper machine. The sheet of fibers leaves the screen at the dotted line. In the lower picture you are looking at the ends of the drying rolls.



Philip Gendreau

been exposed to the weather for a long time. But pick up one of the chips. You can crumble it to powder between your fingers.

For some purposes the gray pulp may be used as it is, but most of it goes next to bleaching tanks. There are several steps in the chemical process of bleaching. Finally, the gray pulp comes out snowy white.

Next comes a thorough beating for the pulp, mixed with much water. You have probably seen pictures of beating machines in your earlier geography textbooks.

In the beater, other materials are added to the pulp. Dye may be added to color the paper. Resin and alum are usually added to keep the paper from soaking up water too easily. Powdered white clay is added to some paper to give it a smoother surface for printing or writing.

A machine makes paper. A little before 1800 a machine was invented to do the work of making paper. The invention was made by a Frenchman, but the rights to use it were sold to an English company. With many improvements in detail, the machine is still used today. It is one of the largest machines

used in industry. A sloppy mixture of pulp and water goes in at one end. Finished paper comes out at the other. The work is done automatically.

Pulp from the mixer is pumped into a tank at the starting end of the paper machine. Before it is ready to go through the machine, more water is added. The material looks about as thick as paint. It is really about 99 percent water and one percent pulp.

The thin pulp goes through devices that spread it evenly across the screen that is to begin the process of turning it into paper. This is an endless belt of wire screen on rollers. In addition to moving forward slowly, the screen shakes at the starting end. The

shaking helps to tangle the fibers together so that they will cling and make strong paper. As the screen moves forward, the water drains out of the fibers.

As the mat of fibers reaches the other end of the screen, it begins to look like a sheet of thick, rough paper. Finally the sheet reaches the place where the screen runs around the last of the series of rolls to return to its starting place. The newly formed sheet goes under a roll and is picked up by a moving band of felt. Riding on the felt, it is carried between several pairs of rolls. One roll of each pair is rubber. The other is brass or polished granite. These rolls squeeze out most of the water and press the fibers tightly together.

Up to this time, the material going through the machine is a mass of fibers, scarcely worthy of being called paper. When it leaves the pressing rolls, it also leaves its felt support. It is still moist, but it is strong enough to hold together by itself. It must still pass through many more feet of machine for finishing. The sheet goes up and down in a zigzag, over and under a great many smooth steel rolls. The rolls are heated by steam let in at the ends. The last few pairs of rolls give the sheet a smooth surface.

From the rolls, the paper goes to a winder that rolls it up so it looks like a big log. On the way, it passes knives that trim the edges to make them straight and make the paper exactly the right width. The trimmings flutter away like ribbons and stack themselves in bins. They will be taken back to the mixing machines, beaten into pulp, and sent through the machine once more.

A big mill has a number of papermaking machines. Each mill usually specializes in a few products. The quality of the paper depends partly upon the raw material and partly upon the way the machine is set up. The largest quantity of paper is newsprint. Other kinds of paper are book paper, writing paper of many kinds, wrapping paper, paper for cartons, and even stiff, heavy sheets of paperboard, for partitions in buildings.

Many Tree Products

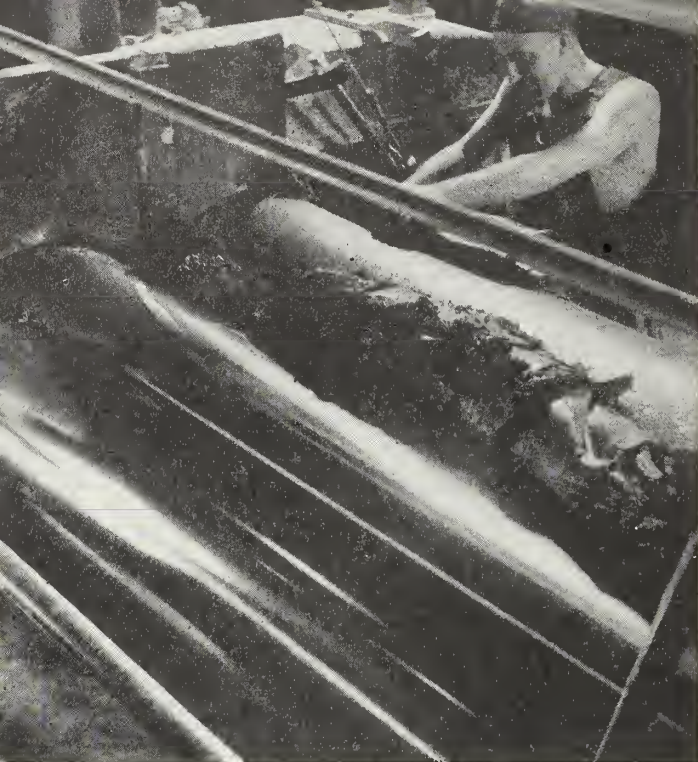
In the chapter on forests, pages 119-142, a great many tree products were mentioned. There is not enough room in this book to tell you how all of them are processed. Some are distilled, like the resin that oozes from pine trees in the South. The products are the liquid, turpentine; the thick fluid, tar; and pitch, which is a solid except when heated. Camphor, sandalwood oil for perfumes, and other products are extracted by distilling the wood of trees.

In the leather industry. Another tree product of great importance is tannin, or tannic acid. A long time ago, someone discovered that soaking hides and skins with the bark or leaves of certain kinds of trees would turn them into leather. In the leather industry, the outer coverings of large animals, such as cattle, are called hides. The coverings of smaller animals, such as sheep and goats, are called skins.

Tanning is the essential process in making leather, but it is not the only one. The hides and skins are washed, soaked in chemicals, and scraped before their long soaking in a solution of tannic acid. The tannic acid is soaked from the ground-up wood, bark, or leaves of various trees. Hemlock, oak, sumac, and several tropical trees are other sources of tannin. The quebracho tree of South America is important.

For many hundreds of years all leather was made by soaking hides and skins in vegetable tannin. It is still the only method for making heavy leather—the kinds often used for shoe soles, luggage, belts, and straps. Lighter leathers are now more likely to be made by soaking the skins in a compound of the metal chromium. Leather made in this way is called chrome leather.

In the rubber industry. Rubber is one of the most important of all tree products. If you have forgotten the first steps in processing it, read pages 109-110 again. Most



Philip Gendreau

You know how the heat and pressure of human hands can mix dough. The same idea is used in a rolling mill, for the heated rolls soften the rubber mixture, and their weight and movement do the mixing.

countries that have modern industries at all have rubber factories, but the largest center of the rubber industry in the world is Akron, Ohio.

At the factory, dirty rubber must first be cleaned. It is ground between ridged

rollers. While it is being ground, streams of water wash out the dirt. The rest of the processing depends upon the use to which it is to be put. It is mixed according to recipes prepared by chemists. A recipe specifies that rubber of a definite quality be used. It names an exact quantity of a vulcanizer, usually sulfur. Other ingredients depend upon the use to be made of the rubber. For most uses, a loading material is added. It may be carbon black, collected from the smoke given off by burning natural gas. It may be ground asbestos, ground mica, certain kinds of clay, or other materials.

The ingredients are mixed on machines called roll mills. Such mixers are used in many industries. They look like huge clothes wringers, with the rolls made of polished steel. The picture shows how rubber is worked on a roll mill. Ingredients for a batch of rubber are fed between the heated rolls. Both rolls turn, but one turns faster than the other. The action of the rolls blends the ingredients thoroughly.

Few articles are made of rubber alone. Rubber tires have heavy fabric inside. The fabric is put in a mold with shaped pieces of rubber and baked under pressure. For rubber overshoes and raincoats, rubber is usually spread on cloth and the two substances are baked together.

PROCESSING EARTH MATERIALS

Before you read further, review what you learned about earth materials from pages 144–153. Some are processed so simply that those pages told all you need to know about them. This is true for most uses of stone and gravel. More complex techniques are used with clay and sand.

Perhaps you should learn a new word for all the products made by baking earth materials. The word is *ceramics*. In its broadest sense it includes even cement, but it is generally used to cover only clay products, and that is how it will be used in this book.

Dishes from Clay

When New Stone Age housewives began to make clay pots, they shaped the wet clay with their hands alone. Perhaps they smoothed it a bit by scraping with a stone or piece of broken pottery. Then someone discovered that better work could be done by holding the tool still and turning the pot against it. This discovery led to the invention of the potter's wheel, the world's oldest machine. In its simplest form, it was a circle of wood or stone mounted on a pivot

in the center. The invention was made early in the Bronze Age. The potter set a roughly shaped dish in the exact center of the wheel. Then, holding his scraping tool against the clay, he gave the wheel a spin. As the wheel spun, the tool scraped the clay smooth and even all around.

In early times an attachment was added so the wheel could be spun from below by the feet. In almost the same form, the potter's wheel is still used in many places in the world. Some of the fine dishes made even in highly industrialized countries are shaped on power-driven wheels.

Even in very early times people began to decorate their dishes by scratching designs in the clay. Later they painted designs and pictures on the clay with earth pigments. When the clay was fired, the pigments were partly melted and burned into it. Still later people learned to glaze their pottery by dipping it into materials that gave it a glassy surface.

Perhaps porcelain dishes are at the top of the modern clay industries. You read on page 148 where fine dishes are made. Porcelain is made of the white clay called kaolin, with other ingredients added. Porcelain dishes are often called china, because the process of making porcelain was invented in China hundreds of years ago. Kaolin is a Chinese word. China clay is a name often used in English for the same kind of earth.

Porcelain must have the right clay and other ingredients, but the real secret of porcelain making is in the baking. It is baked so hard that the clay is partially melted all the way through and becomes translucent. When you hold a porcelain dish up to the light, you cannot actually see through it as you see through glass, but the light does show through.

Porcelain and ordinary pottery dishes may be shaped by hand or turned on a power-



Erving Galloway

Finishing off a piece of pottery on a potter's wheel in a modern porcelain plant. The workman braces the tool against a stick to hold it steady. He sponges the clay to keep it moist.

driven potter's wheel. Many are pressed into shape. The finer varieties are baked inside clay boxes so an even temperature will be maintained even while they are baking.

Dishes are not the only clay articles we use. There is not enough space to tell about all of them, and we must choose one to stand for the rest. Similar methods are used in all, but we shall consider one of the newest and most highly mechanized branches of the industry, the making of electric insulators.

New methods of shaping clay. Clay insulators are widely used—tiny ones to hold the lead-in wires for telephones, oddly shaped ones in electrical apparatus, large ones to carry the wires on power lines. They vary in shape from tiny tubes to huge, grooved cones (the grooves are to hold the wires) almost as tall as you are.

Some of the larger and simpler pieces are cast. The molds are plaster of Paris, which is a ceramic product itself. It is made by burning a rock called gypsum. By the most common method, the objects are pressed into shape on a machine. Part of the machine is a flat table with an opening in the center. Into this opening a die is fitted. To make it very simple, suppose the insulator is to be

a tube, as many of them are. The die is then just a cylindrical hole.

From a bin beside him, the worker picks up a handful of slightly damp clay. He drops it into the opening and touches a lever. From above, a plunger comes down with great force. On the end of the plunger is another die to complete the shape of the object. In this case it is just a cylinder to form the opening in the tube.

The clay is squeezed very tightly between the two dies. Even when the shape is much more complex than a simple tube, the moist clay is forced into every tiny space. When the plunger goes up, the machine releases the object it has shaped. The operator picks it up and sets it on a board.

The operator works fast. Soon he has a board covered with tubes or whatever else he is making. The objects are firm enough to handle. A workman picks up the filled boards and places them on racks in a drying room. There the clay is allowed to dry for many hours. The time depends upon the size of the objects.

When the clay is nearly dry, it is ready for firing. First, though, a glaze is put on to give the insulators a waterproof surface. The glaze is sprayed on. For large or complex objects, the spraying is done with spray guns, like the one the woman in the

picture is using. Simpler shapes are set inside a spray box, and the spray comes from all directions at once. One glaze commonly used is a beautiful pale green. It is disappointing to learn that the color will turn to an uninteresting brown in the firing.

Baking the clay. Now we come to the firing. There are many kinds of kilns and ovens, but our factory has one of the latest and most efficient. It looks like a very long, low room built inside the factory. Waiting beside it is a small steel flatcar. The car has two levels, one above the other, and is loaded with clay objects of many shapes and sizes.

Inside the open door of the oven we see a strong steel plunger touching the end of another car like the one waiting outside. The workmen say it is pushing the car, but the movement is too slow for you to see. It is pushing a whole train of cars that reach all the way through the oven. When a car is pushed out at the other end, the waiting car will be added at the starting end.

Step inside the oven a moment. It is not hot here at the door. You see the train of little cars stretching away. In the distance there is an incredible brightness. The whole inside of the oven seems to glow like the sun.

When you are outside again, a workman leads you halfway down the length of the oven. He tells you that, inside, the objects on the little cars are being heated slowly. They are moving into areas of higher and higher temperatures. Finally he stops and opens a small peephole. Now you are looking straight into the brightness you saw from the end of the oven. The clay objects are white hot and give off bright light like the incandescent filament in a lamp bulb. The dull little steel cars are a brilliant cherry red. The walls of the oven glow. The very air glows in fiery clouds from the flame of burning gas.

The workman closes the peephole. It is not good to look into such brightness too long.

Glazing in England, where fine dishes are made.

Courtesy British Information Services



Inside the oven the little cars move on, carrying their loads slowly out of their bath of fire. The glow dulls. Then the cars are again gray steel, just as they were before. But the objects they carry will never be the same again. They went in as shapes of molded clay and will come out as pottery.

Glassmakers

Another material we see all around us is glass. The techniques of glassmaking are very old and very new. As you read on page 145, the basic invention of glass is very old. Clean sand, with the right chemical composition, is the principal raw material for glass. Ancient peoples discovered that glass could be cast in molds. They also discovered that it could be blown and drawn out into many shapes. Both techniques are still used.

Fine glassware is still blown. The principal tool of a glass blower is a long tube or pipe. He melts a batch of glass in a kind of pot called a crucible, keeping the glass in the crucible so hot that it is about as thin as molasses. Into this he dips the end of his pipe and picks up a blob of glass. Then he blows. By blowing while he whirls, twists, jerks, and waves the pipe, he can make the glass take any form he wants, if he is skillful enough. He uses rods to draw parts of it out, and shears to snip off extra bits or smooth the edges. He can also stick together pieces shaped separately.

There are three processes for making flat sheets of window glass. For plate glass the melted material may be poured out on a flat surface. In another process, glass comes from the furnace through a narrow slit. In the third it is drawn out of the furnace between rolls. Plate glass differs from ordinary window glass chiefly in being ground and polished very smooth.

Glass as we know it has other materials than sand in it. These materials vary according to the purpose of the glass. The composition of glass that will stand the



Courtesy Danish Information Office

He's blowing bubbles—glass ones. A good glass blower has not only great skill, but also lung power. The man in the picture is employed in Denmark.

heat of cooking is not quite the same as the composition of window glass or glass dishes, for example.

A method of making fibers from glass was discovered not very many years ago. Melted glass is allowed to leak through tiny holes. It comes out in long strands, but these strands are still not thin enough. As they come through the small holes, they drop into a strong blast of air or steam. The blast stretches them out much longer and thinner.

A mass of the glass fibers looks and feels like soft wool. In that form the fibers may be used as insulation. On ordinary textile machines they may also be woven into cloth. Glass cloth is fireproof and may be used

for curtains and upholstery in public places, where fire is especially dangerous.

These are not the only methods of handling glass. It can also be cast in molds, poured out in sheets and rolled, or pressed in forms. After it has hardened, it can be cut with abrasive wheels or a sand blast to form attractive patterns.

Glass is shaped in about the same ways that metal is shaped. In fact, glassworkers use the word "metal" for glass that is in a melted or plastic state so that it can be worked. It is not metal, however, as the word is generally used outside of the glass industry. It is time to turn, now, to a discussion of real metals.

METALS AND METALWORKERS

It was a hot day in the little city of Ezion-Geber. A fleet of small, square-sailed ships scudded southward before the wind, down the Gulf of Aqaba to the Red Sea. The wind blew a gale from the north, as it nearly always did. The strong north wind blew down the narrow, rock-walled desert valley like a blast from a furnace.

Down the trail that led into the valley from the east wound a long caravan of camels loaded with charcoal. The camel drivers pulled the loose cloth of their hoodlike head coverings over their faces as they came down into that blast of hot air, for the wind was filled with sand that cut like little knives.

Slowly the camels plodded on. From the camel beside him the head driver lifted his goatskin water bag. He tilted it to his mouth and drank the last of the fresh water he had brought from Edom. Tonight he would drink brackish water in Ezion-Geber before he slept beside his camels in the square.

The brick walls of the fortress-like city seemed to waver in the heat. Black smoke rose from the grim, square building set in the center of the north wall. The wind caught the smoke, carrying it in ragged streamers across the city and out over the Gulf of Aqaba. "What a place to build a city!" thought the head camel driver.

"What a place to build this city!" thought the cocky young man who stood on the walls watching the caravan. "How wise is King Solomon! How wise to plan this place! How wise to choose me as superintendent of

this place! Who else in the kingdom knows so much about the working of metal?"

This is just a story, and perhaps no one ever had exactly the thoughts written here. Perhaps no cocky young plant superintendent ever stood on the wall and boasted to himself about the work in his charge. But there was a brick-walled city of Ezion-Geber at the head of the Gulf of Aqaba. It was built by order of Solomon, King of the Hebrews, almost three thousand years ago. Camel caravans did bring charcoal from the hills of Edom, which lay to the northeast. The water really was a little salty—in fact it was just barely drinkable. And the climate was as bad as the story says it was. The terrible climate was the real reason for choosing this spot for the city.

There were large deposits of copper and smaller ones of iron in the surrounding regions, but they were not the reason for building the city exactly here. It could have been built a few miles away, out of the wind, and still have been near the mines. But those terrible winds were the reason for choosing this place and no other.

A deep, steep-walled valley stretches northward from the Gulf of Aqaba to the Dead Sea. If you look carefully, you can find this valley as a narrow band of green on the map on pages 390–391. The valley acts like the draft of a furnace, drawing the air southward. That was just how Solomon's engineers used the winds—as the draft for a furnace. They built a smelter on the north side of the city, facing the wind. In the

wall were two rows of openings like port-holes. From these openings flues led to the various rooms of the smelter. The flues were small tunnels left in the brick walls. When the wind blew through the flues, it provided a forced draft for the fires.

You probably know that fire will not burn without a draft. A clay oven or furnace will not work if it is tightly closed. There must be openings at the base and at the top so that air can circulate through the fire. Metalworkers learned very early that, if they could provide a forced draft, fires would burn hotter. Very old Egyptian pictures show the metalworkers using bellows to force air through the fire. The African blacksmith whose work is described on page 154 also uses primitive bellows.

Now you see the wisdom of Solomon in choosing a location for his metal-working city. He and his metallurgists (experts who understand the principles of metal-working) knew all about the need for a forced draft. Those fierce winds whistling through the flues could do the work of hundreds of men kneeling around clay furnaces, working bellows up and down.

Metal from Ore

All metals known to people of ancient times can be secured from the ore by the use of heat. We still use the same method, but our furnaces produce a degree of heat such as Solomon never dreamed of. The fires are whipped up by blasts of air that make the winds blowing upon Ezion-Geber seem by comparison like gentle breezes. Our best example of this method is the blast furnace used to secure iron from iron ore.

Smelting iron for steelmaking. You have seen pictures of steel mills in your geography texts. There is always a row of tall, round buildings. The most complicated one in each group is a blast furnace. The others are called stoves. A blast-furnace stove is about 22 feet across and 100 feet

high. Inside, the stoves are filled with special bricks laid up so that there are air spaces between them. Ordinary brick would melt. The bricks in the stoves are made of earth materials that can withstand a very high temperature. These are called refractory materials, and the bricks are refractory bricks.

Huge gas burners at the bottom of the stove heat the bricks very hot. Then the workmen turn off the gas burners and blow a blast of air through the hot bricks. The heated air is led in pipes to the lower part of the blast furnace.

Now look at the diagram of a blast furnace on the next page. At the right little cars loaded with ore, coke, or limestone are pulled up the track by machinery. At the top they dump their load into the blast furnace.

Hot air from the stoves is blown into the furnace at the bottom, through pipes. The draft causes the coke to burn with an exceedingly hot fire. Temperatures are marked beside the blast furnace. The blast furnace itself would melt at those temperatures if it were not thickly lined with refractory bricks.

Burning is a chemical reaction, but it is not the only one that goes on in the blast furnace. Iron ore is a compound of iron and oxygen. The burning coke gives off a gas that unites with the oxygen in the ore, leaving the iron. Because of the great heat, the iron melts and trickles down to the bottom of the furnace. The limestone is first burned to lime and then unites with impurities from the ore and coke to form slag. The slag, too, is melted and trickles to the bottom of the furnace. Slag is lighter in weight than iron, and so the melted slag floats on top of the melted iron as cream floats on milk. Gas collects at the top of the blast furnace. It will burn and is led away in pipes to heat the stoves.

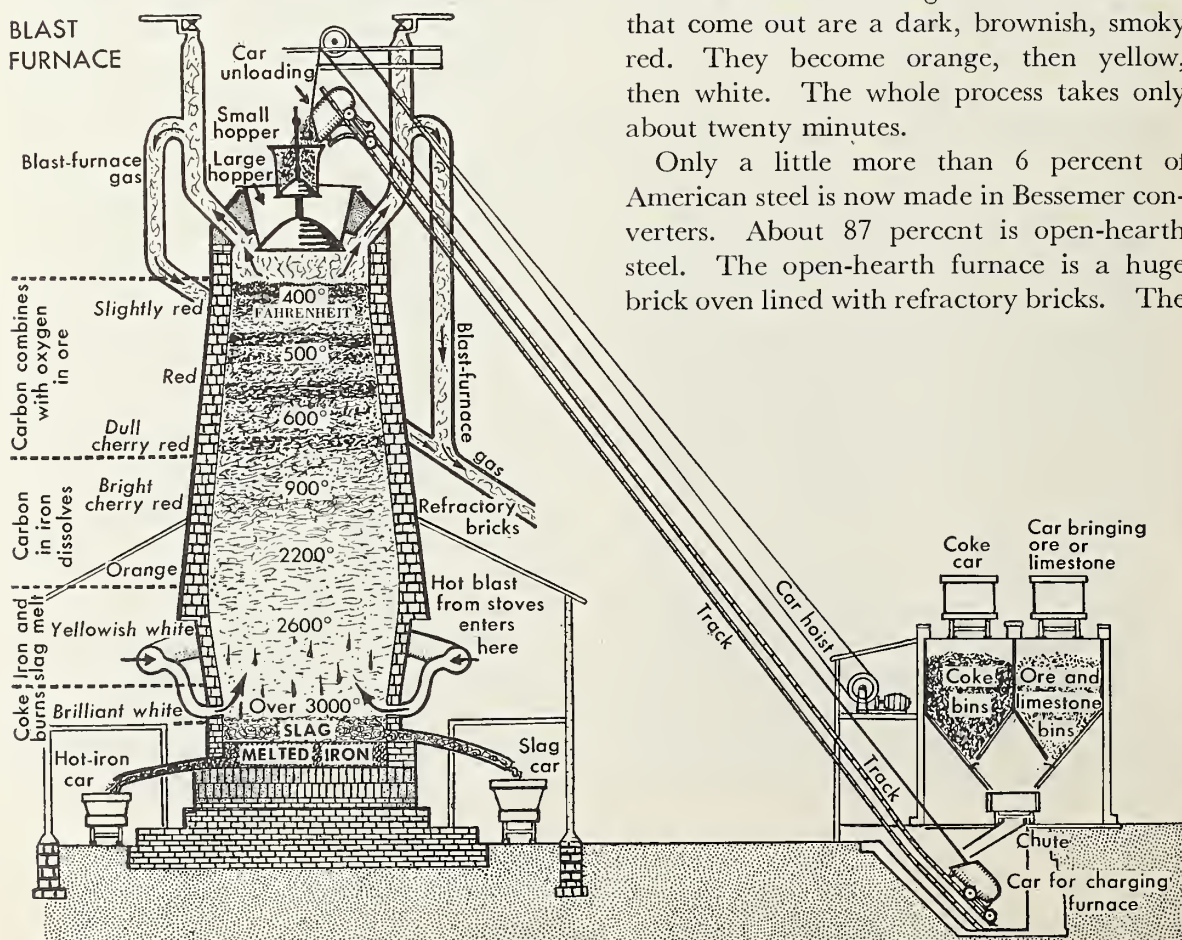
At intervals the furnace is tapped to remove the slag and iron. Openings into the furnace are plugged with clay. To tap the furnace, a workman with a long bar knocks out the clay plugs. The hole at the level

of the slag is tapped first, and the slag pours out into a kind of bucket on wheels. It is not wasted. It may become raw material for cement, it may be used in making roads, or it may become insulating material for a building.

Iron, as it comes from the blast furnace, is called pig iron. Most of it is made into steel. Pig iron contains a large percentage of carbon, absorbed from the coke in the blast furnace. Part of the carbon must be removed to turn the iron into steel.

All carbon will burn—even diamonds. The way to get rid of carbon is to burn it out, but the burning requires extremely high temperatures. Early steelmakers heated iron in crucibles. They could make only a little steel at a time, for nothing will burn without oxygen. Air, which is partly oxygen, could not reach the center of a large quantity of melted iron, and so the carbon could not be burned out.

A diagram to show how the blast furnace works.



As you read on page 154, the first modern furnace for making steel was the Bessemer converter, invented in the middle of the nineteenth century in England. The first one in the United States was built in 1864.

A Bessemer converter looks like a huge kettle, more than ten feet high. It is made of steel lined with refractory materials, and holds from fifteen to twenty-five tons. The giant kettle is mounted so that it can be tipped over for loading and for pouring out the finished batch of melted steel.

A converter would not be a very good cooking kettle. It has holes in the bottom. When the converter has been loaded with melted iron and turned upright, a strong blast of air is blown through the holes. The air keeps the iron from leaking out, but its real purpose is to burn most of the carbon out of the iron. No fuel is added. In the red-hot mass of liquid metal, the carbon burns as soon as it is touched by bubbles of air.

The mouth of a Bessemer converter is uncovered, pointing toward an opening in the roof of a steel building. The first flames that come out are a dark, brownish, smoky red. They become orange, then yellow, then white. The whole process takes only about twenty minutes.

Only a little more than 6 percent of American steel is now made in Bessemer converters. About 87 percent is open-hearth steel. The open-hearth furnace is a huge brick oven lined with refractory bricks. The

bottom is in the shape of a shallow basin, usually about seventy feet long and twenty feet wide. The furnace is loaded (charged is the correct word) with crushed limestone, pig iron, and scrap steel.

At each end of the furnace are huge burners. Gas is the usual fuel. Sometimes it is natural gas, sometimes gas given off in the process of making coke, sometimes gas from the blast furnaces. Blasts of hot air blow the flames over the furnace charge, from one end and then from the other. The materials melt, and carbon and other impurities begin to burn out. The process takes from six to twelve hours, but the result is about 150 tons of steel instead of the 15 to 25 tons made in the Bessemer converter.

The newest steelmaking device is the electric furnace. This looks like a huge closed

A trainload of ingot molds being filled by a huge ladle. As it passes over each mold, a stopper in the bottom of the ladle is lifted, allowing a stream of the liquid metal to escape.

U. S. Steel photo



© G. A. Douglas from Gendreau

An electric furnace tilted to pour out the liquid steel.

kettle with rods—usually three—rising from the top. The rods are made of carbon, and they extend to within a few inches of the melted iron inside the furnace. An electric arc is set up between each carbon stick and the metal, producing great heat. The furnace is mounted so that it can be tilted to pour out the steel. Electric furnaces are used for some of the finest alloy steels because the whole process can be controlled more closely than in the other type of furnace.

However the steel is made, it is poured out of the furnace into a huge bucket called a ladle. The ladle is lifted by an overhead crane to a row of iron ingot molds, which are then filled with the hot





U. S. Steel photo

Ingots being stripped of their molds. They have stood about one hour after being poured, in order to make stripping possible. Ingots usually weigh between 5,000 and 40,000 pounds.

metal. The molds are sitting on steel railway cars. They have no bottoms, but rest on iron plates. A locomotive pulls the cars and filled ingot molds outside the building, where the ingots cool and harden. When the steel has become solid, but while it is still red hot, the molds are removed, as you see in the picture. They are lifted off by tongs reaching down from an overhead crane.

Heat and electricity. While the ingots cool a little, we might see how the treatment of other ores differs from the treatment of iron. A blast furnace is a kind of smelter. Somewhat different kinds of smelters are used for extracting many other metals from the ore. Smelting was the only method known in earlier times.

Now, electricity is used in refining a number of metals. This is how it is used in refining some ores of copper. The ores are crushed and covered by a chemical solution containing sulfuric acid, which is a

liquid compound of sulfur and oxygen. The solution dissolves the copper out of the ore. Then it is drained off into a long tank. Hung at intervals in the tank are thin sheets of copper. Between them are plates of other materials which are attached to electric wires. When a powerful current is turned on, a strange thing happens. The solution is a conductor of electricity. The electricity comes into the tank, passes through the solution, and goes out by way of the copper sheets. The sheets seem to grow until they become thick plates of copper. Atoms of copper are in the solution. As the current passes through, the atoms of copper attach themselves to the copper sheets. The workmen do nothing but prepare the apparatus, turn on the current, and take out the plates of copper. Even when the copper ore is first reduced by smelting, the metal usually goes through a similar electric process for refining. In that case, the electricity enters by way of plates of impure copper from the smelter. The atoms of copper leave these plates and are deposited on the thin sheets of pure copper. Other materials are left behind.

Similar methods are used for recovering other metals from the ore or for refining them. Most of these metals can be obtained in other ways, but we could not have one of our commonest metals at all without electricity. That metal is aluminum. It is possible to get aluminum from the ore by other processes, but they are so costly that if we depended upon them we could not have aluminum pots and pans or even aluminum in airplanes, trains, automobiles, and trucks.

You read a little about aluminum on pages 166-167. Compared with copper, tin, lead, or iron, it is a very new metal. The first metallic aluminum was produced in 1825 by a Danish scientist, but only a few tiny bits. In 1845 a German scientist produced a little more by another method. A French scientist improved on the German's method, and, at the Paris Exhibition of 1855, he had a whole bar of the metal on display.

In 1885 came the work of Charles Martin Hall, the young student at Oberlin College, in Ohio. First he tried many experiments to find something that would dissolve aluminum compounds. He finally found one rare substance—melted cryolite. Then he passed an electric current through the solution. Hall found pieces of metallic aluminum at the bottom of his solution.

This you will find hard to believe, but strange things have happened in the history of inventions. A young Frenchman, whose name was Héroult, was working on the same problem, at the same time. He was just Hall's age—22. Neither young man had ever heard of the other, but they both made the same discovery in the same year.

Aluminum is obtained from the ore in two steps. The product of the first series of processes is alumina, which is a compound of aluminum and oxygen. It is obtained from bauxite by complex chemical processes. Then the Hall-Héroult process comes in. Powdered cryolite is placed in long vats which are lined with carbon. Carbon rods carry the electricity into the vat. When a powerful current is turned on, the cryolite melts. Then the workmen stir in the alumina, which melts in the bath of melted cryolite. The oxygen in the alumina forms a compound with the carbon. Pure aluminum falls to the bottom of the tank.

The Hall-Héroult process requires huge quantities of electricity. It requires such huge quantities that the work is done only where hydroelectric power is available. The first really large hydroelectric development in America was at Niagara Falls. The first large industry to locate there because of the power was an aluminum plant. When the first power dam was built on the Tennessee River, one of the first customers for power was an aluminum company. After the construction of the great dams in the Northwest, aluminum plants were built there. These three areas, with one other on a tributary of the St. Lawrence, are the aluminum-producing regions of America. Other re-

gions have plants for producing alumina from bauxite; others have factories for making finished products from the metal. But for extracting metal from alumina, there must be power in quantities.

As you read on page 167, some regions with large deposits of bauxite and many mines have no aluminum industry at all. They are regions that are not highly industrialized and have little power development. Other regions have factories for making finished aluminum products but no plants producing aluminum from the ore. They are located near densely populated industrial areas, where there is a large market for aluminum machine parts, household utensils, and transportation equipment.

Shaping the Metals

Perhaps you have noticed that in talking about how metals are extracted from the ore, not much has been said about workmen. As a rule, equipment for getting metal from its ore does not require many workmen. Great weights of material are handled, usually at very high temperatures. Such materials must be handled by mechanized equipment. Few workmen are needed. Shaping the metals into useful products is another story. This part of metalworking requires many people. The following pages will tell you a little about their jobs.

You read about how steel ingots are cast in ingot molds. Most metals, as they come from the smelter or refinery, are cast in ingots or bars. Sometimes the plant that produces the metal from the ore also has shops for shaping the metal into finished products. Sometimes the smelter or refinery does not carry the work beyond the casting of ingots. Other manufacturers buy the ingots and carry on the work. In other words, ingots may be the finished product of one plant and the raw material for another.

Whether the work is done in one plant or several, methods are much the same. The same basic techniques are used, too, regard-

less of the kind of metal. Details differ, of course, and not every technique can be applied to every metal.

Forging. On page 153 you read that most metals are malleable. They can be shaped by hammering. The technique of shaping a metal by hammering is called forging. Less than a hundred years ago, almost every village in the land had a blacksmith shop. The blacksmith shaped wrought iron into needed objects by forging.

Now, there are few blacksmiths. Most forgings are made on huge power machines. You saw a picture of one of these machines on page 2 of this book. It is called a drop forge. Power lifts the great hammer in the center of the forge. The hammer drops by its own weight on the hot metal beneath it.

Forging is the oldest technique for shaping metals. It is still important, but it is now used only for pieces that must have great strength. Even with great modern power hammers, the method is slow, for the article

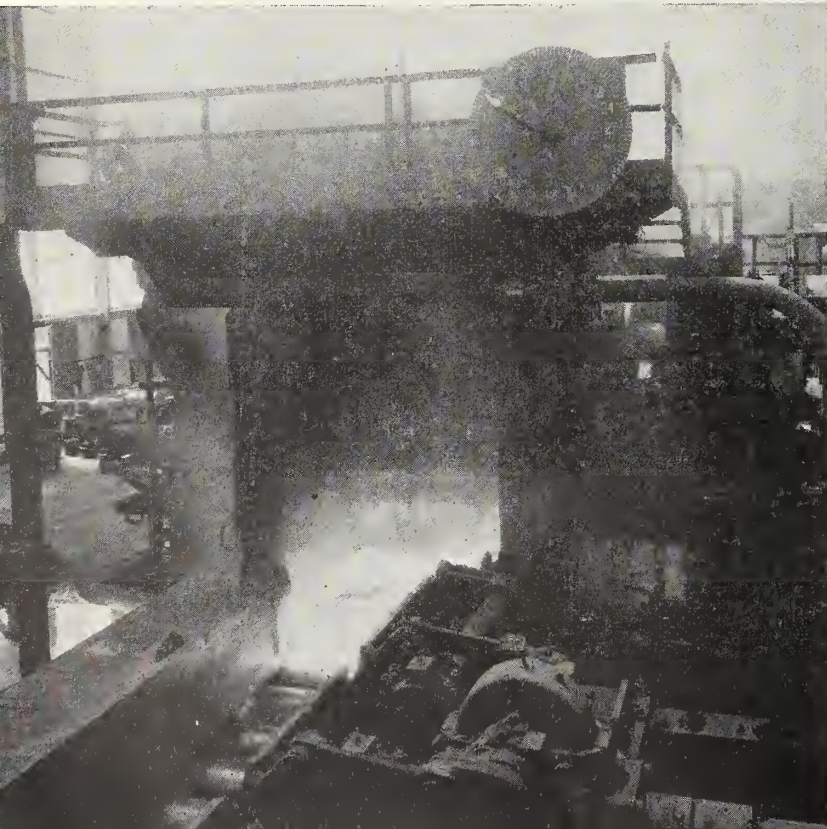
is shaped by thousands of separate hammer blows. A workman at a drop forge must turn the hot piece of metal constantly so that the hammer blows strike it at the right spots to shape it. No automatic machine turns the metal into the right position. If it is a small piece, one or two workmen hold it and turn it with long-handled tongs. If it is a large piece, slings of chain may support the weight, but men with tongs still place it in position.

Rolling mills. Probably today a greater weight of metal is shaped by rolling than by any other technique. There are many types of rolling mills. They differ in detail, but basically they work like the rolls in a clothes wringer or in a flour mill. Rolling mills are used to shape nearly every metal and alloy except cast iron.

Rolling mills shape metal into flat plates, sheets, and finished products, such as beams for buildings and rails for railroads. To learn how a rail is made, we must go back to

An ingot passing between the rolls of a rolling mill. This particular ingot will be rolled many times until it has become a flat piece of steel an inch or two thick, called steel plate.

U. S. Steel photo



one of the ingots we left cooling outside a steel mill. Often before the ingots have even lost their redness, they are hauled to the rolling mill.

Before it is rolled, an ingot must be heated again. It is lowered into a pit heated by gas flames and left there until it is the right temperature all through. Then the great tongs lift it out of the pit. The crane carries it to the first rolling mill. There it is rolled back and forth until it becomes longer and thinner. It is now called a bloom.

It is picked up by a crane with his power-operated tongs and taken to other rolling mills. They roll the piece of steel out longer and longer and thinner. Each time through the rolls is called a pass. After a few passes, the steel begins to look a little

like a rail. The surface of the rolls is cut to give the rails the right shape.

After many passes, our ingot has become a rail. It is much longer than the rails you see in a railroad track. In fact, it is much too long to handle. The long rail is not as straight as a rail should be, either. It goes through straightening rolls to take the kinks out. Then workmen with power saws cut it into measured lengths.

Metalworkers have always wanted to use thin plates and sheets of metal. For rolling steel sheets, the start is a bloom. When other metals are to be rolled into sheets, they are usually cast as slabs, which look very much like boards. Copper, brass, aluminum, and other softer metals are rolled cold. Steel must be kept hot until it has become very thin. The thinning is done by many passes through steel rolls.

Sheet steel may be thick enough to have machine parts cut out of it, or it may be as thin as the steel under the coating of tin in a tin can. Aluminum, lead, and tin are rolled into the very thin sheets called foil. The next time you strip a piece of metal foil off a chocolate bar or a package of gum, think about how that paper-thin bit of metal came to be. It started as a white-hot liquid, was cast in a thick slab, and then it was rolled and rolled and rolled, over and over and over again, between polished steel rolls.

Rods, tubes, and wire. Have you ever squeezed tooth paste out of a tube? If you have, you can easily understand how metal rods are made—a brass curtain rod, for example. The process is called extrusion and the rod is said to be extruded. This process is not used for steel, but is the regular one for making rod from brass, copper, aluminum, and other softer metals.

For rod, the metal is cast in billets, not slabs. Billets look like short sections of log. The billets must be red hot for the extrusion machine. A glowing billet moves along on a conveyor into the machine. In-



Courtesy The International Nickel Co., Inc.

A powerful ram is pushing a red-hot billet of metal into the back of an extrusion press. It will go on pushing until the metal has been forced through the die inside the machine.

side the machine is a die made of hard alloy steel. In the center of the die is a hole exactly the size and shape of a cross section of rod. The billet moves into a space back of the die and just large enough to hold it. Behind it a heavy steel ram pushes it against the die. The pressure is so great that a rod of metal is squeezed out through the die just as you squeeze tooth paste out of a tube. Thick rods are cut into straight lengths. Thin ones are coiled.

Other shapes, including tubes, can be extruded. There are several ways of getting the hole into a tube. In one method, a round plug is first pushed out of the center of the billet with a rod. A rod extends through the hole in the billet and into the opening of the die. The metal is extruded between the walls of the die and the rod.

Steel is too tough for the extrusion process. Therefore steel rod is rolled. For round rods, thick strips of steel are first slit into square rods. Then they are passed through several sets of rolls grooved to squeeze the square rod into a round one.

The picture at the top of page 252 shows one way of making a steel tube. You can see how the rolls bend the strip of red-hot steel until the edges meet. Then an electric



Courtesy Bethlehem Steel Co.

This picture was taken by the light from a strip of red-hot steel. The steel is being folded into a tube by passing through a succession of grooved rolls. It is moving from left to right.

current heats the edges until they melt together. Joining edges of metal by melting them together is called *welding*. Welding is not always done with electricity. Sometimes it is done with a blowtorch that blows flaming gases against the metal. A little more metal is usually added. It melts and trickles into the crack.

With all that you have learned about metals, you have not read about many finished products—only rails and structural

steel. If you look around you at all the metal objects you see, you will realize that this book can tell you about only a few. There are too many articles, shaped by too many different techniques.

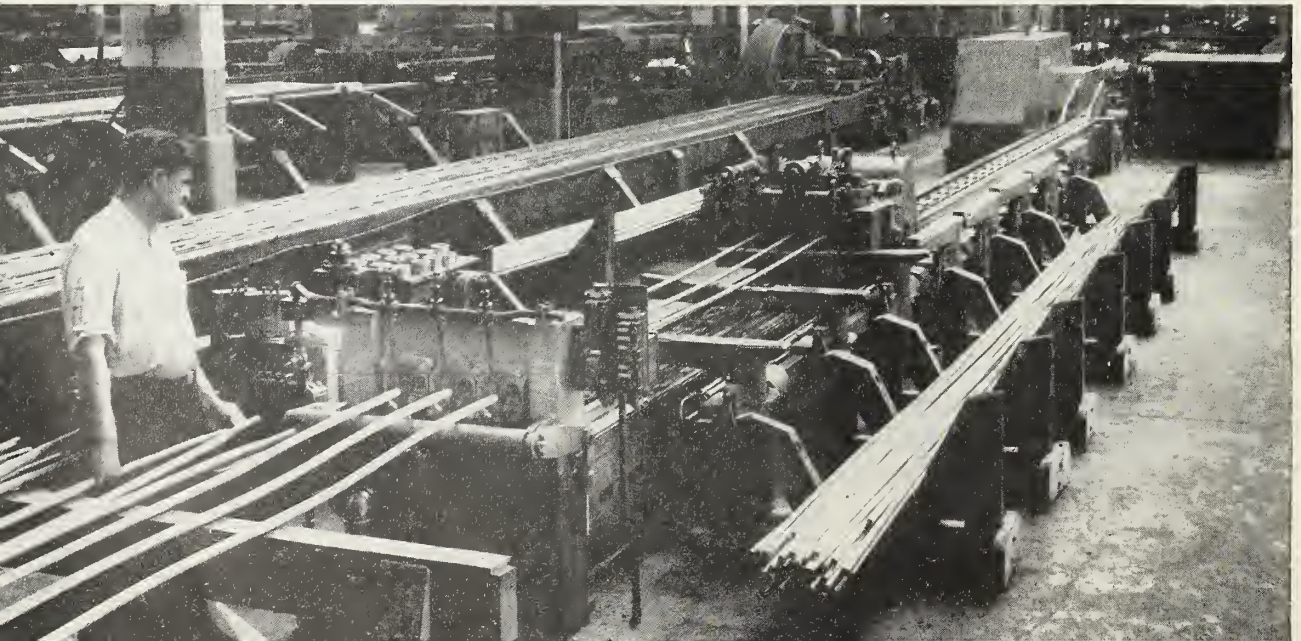
Most metals can be drawn into wire, but the greatest quantities of wire are made from steel and copper. Steel wire is used for many purposes. Most wire fences are woven from heavy steel wire. The great cables that hold up suspension bridges, the cables that dangle from cranes, the cables that lift the buckets and scoops on power shovels—all are spun from strong steel wire. Copper wire is used even more, for most electricity is carried on copper wire.

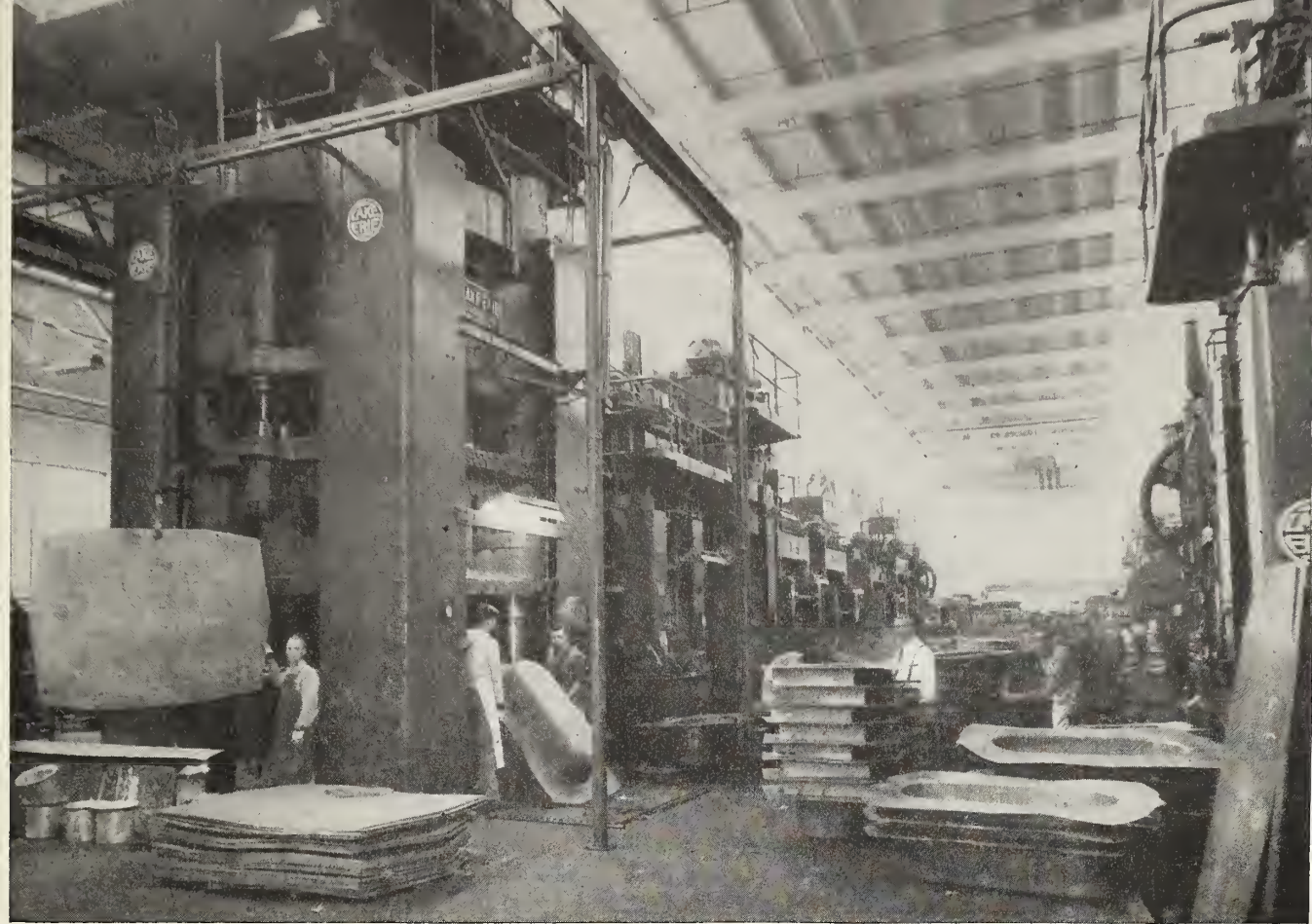
Wire starts as thin rod. At the wire mill a workman sharpens one end of a rod and threads it through a die. The die is just a piece of hard steel with a hole through it. The width of the hole is a little less than the thickness of the rod. After the workman has threaded the sharpened rod through the die, he grips the tip with pliers and pulls. He may do this by hand, or the machine may be equipped to do the pulling.

Most wire-drawing machines have several dies in line, each a little smaller than the one before. The metal is threaded through

These rods will become wire. They are passing through dies three at a time and are drawn smaller as they go. After going through many dies they become so thin that they are called wire. Not all wire is round. It has other shapes and may even be square. There are over 90,000 uses of wire products.

Courtesy Scovill Manufacturing Co.





Courtesy Lake Erie Engineering Corp.

A big press in action. Each of the sheets of steel stacked at the left will become a five-foot bathtub. The sheet being lifted will be next. It will be pressed into shape in less than two minutes. Then it will be trimmed. You never see the steel base in a finished tub, for it is covered with a glossy enamel.

one die after another and then attached to a reel at the end. The machine draws the wire slowly through the series of dies and winds it on the reel.

Dies must always be harder than the metal being drawn; and the finer the wire, the harder the die must be. For the first draws of copper wire, hard alloy-steel dies will do. For later draws and for drawing steel wires, tungsten carbide dies are used. Tungsten carbide is very hard. It is made by mixing powdered tungsten, carbon, and other materials and baking them under great pressure. Very fine wires and wires of very tough steel are usually drawn through diamond dies. These dies, made of the industrial diamonds you read about on page 149, are harder even than tungsten carbide.

Punches and presses. Many articles are made by drawing metal into shape on presses. The aluminum kettle in your kitchen at home was probably drawn. So were parts of your lamps and clocks, hundreds of different kinds of containers, and parts for machines and equipment of all kinds.

Suppose the article to be produced is an aluminum pan. First a machine operator feeds a sheet of aluminum into his machine. In general appearance, his machine looks much like the forge in the picture on page 2. Instead of a hammer, a circular knife comes down and punches out a round piece called a blank. The machine cuts the blanks very fast, and it is very noisy.

The blanks are taken to a punch press. It belongs to a large family of machines from

huge two-story-high affairs to little ones not much larger than typewriters. They all have one thing in common—a plunger that comes down with great force. On the end is a shaped piece of steel called a punch. It can be changed according to the object that is to be made. Set into the flat steel table of the machine is a die shaped like the outside of the object to be made.

The machine operator lays a blank over the hollow in his machine. Markers show him exactly where to place the blank. He touches a lever, and down comes the powerful punch. It draws the metal into the hollow of the machine and lifts again. The operator takes out the shaped piece of metal, puts in another blank, and touches the lever again. Again the punch comes down.

A pan is not ordinarily drawn in one operation. The metal might tear or wrinkle around the edges. The first draw on our aluminum pan probably shapes the blank into a shallow bowl. The next deepens it and begins to pull it into a pan shape, with a flat bottom and straight sides. A number of draws may be needed to give it the final shape. Each is on a different machine.

Many different objects are shaped on punch presses. Similar machines stamp designs into metal objects and punch out and bend pieces of sheet metal. They make such things, for example, as parts of door hinges. Even large pieces of metal, such as automobile fenders or the bathtubs in the picture on page 253, are shaped in presses. Most of the large pieces are shaped on slower presses that force the metal into a form.

Casting. Now you have caught glimpses of a good many ways of working metal. But in all the description, the second oldest technique, casting, has barely been mentioned. Even before metalworkers had learned to use bronze, they knew how to cast copper. Many of their molds have been found. They are made of stone, in two halves. Imagine two flat stones hollowed out so that when they are fitted together the hollows will have

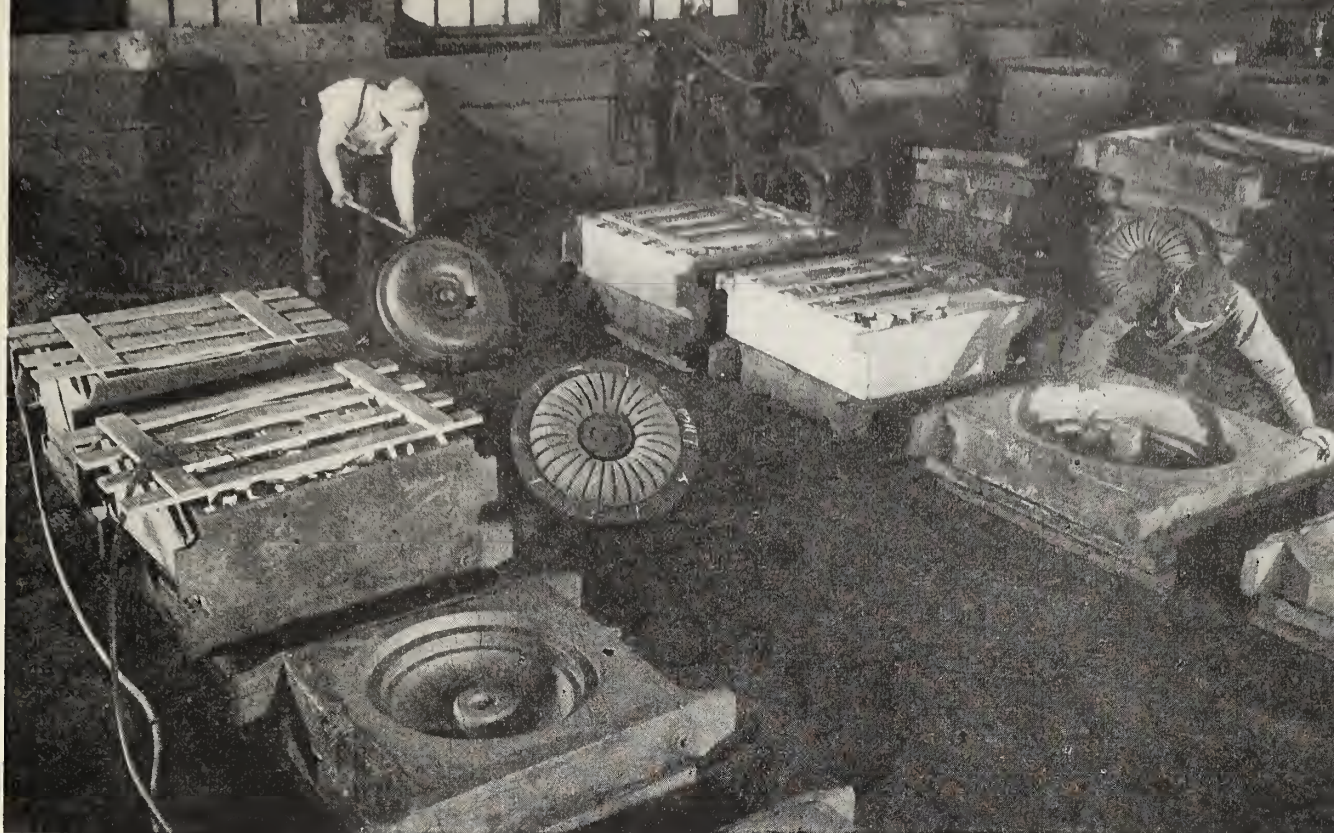
the shape of an ax blade. Through a small opening left for the purpose, the metalworker poured melted copper until the hollow was completely filled. After the copper had had time to cool, he opened his mold and took out a new ax blade.

The blade was not finished when it came out of the mold. Where the opening led to the surface, a kind of rough rod stuck up on the ax. Around the edge was a thin fringe of metal, where the melted copper had spread into the crack between the halves of the mold. The edge of the blade was rough and dull. First the metalworker broke off the extra pieces with stone chisels. Then he polished and smoothed the surface with stones. Finally he sharpened the edge, probably by hammering and grinding.

Stone molds are not used any more, but another ancient method of casting is still the best technique known for casting large objects. This is sand-casting. Look at the picture at the top of the next page. In the foreground you see a mold prepared to form the shape of one side of a casting. The sand was shaped around a wooden pattern. A similar mold will be made for the other side of the casting. When the halves are fitted together, they form the boxlike arrangements you see beyond the open mold. These are called flasks.

Inside the flask is an opening exactly the shape the finished casting is to be. For casting more complex shapes, cores are used. Cores are molded shapes put in place after the pattern has been removed. In a hollow casting, for example, the sand for molding the hollow would be broken in taking out the pattern. Therefore this part is put in later as a core.

A channel must be left reaching from the hollow mold inside the flask to the surface. Melted metal is poured down this channel until the opening is filled. A ladle swings along over a row of flasks, filling one after another. The metal hardens to form the castings. When the castings have cooled enough, the flasks are opened and the sand,



Courtesy American Foundrymen's Association

Have you ever pressed a shape into wet sand? These men do this all day. The sand is carefully sifted and moistened with materials that hold it together. They put it in a board frame and shape it around a wooden pattern. The poured metal takes the shape of the mold. One man is brushing a finished mold.

which has become quite hard, is broken away. The sand cores are broken out, too.

Metal molds are used for some castings. One special method of casting in metal molds is called die-casting. It cannot be used for iron or steel, but only with metals that have a lower melting point. Zinc and aluminum are most common. In die-casting, the mold is cut into two pieces of metal that fit together. The liquid metal is squirted into the mold under pressure and fills all the tiny spaces very exactly. The technique is used for casting parts of automobiles, airplanes, engines, refrigerators, radios, and a great many other articles.

There are still other methods of casting, but what you have read gives you an idea of the basic methods. Any material that can be melted can be cast. Some cannot be worked in any other way. For example, iron, as it comes from the blast furnace, is used for making pipe, parts of stoves, and

many other articles. It can be shaped only by casting. In fact, the names cast iron and pig iron are often used interchangeably. Steel is frequently cast. So are nearly all other metals. A plant in which metals are cast is called a foundry.

Machining to exact measurements. Do you remember what the primitive metalworker had to do to his ax blade after he cast it? He had to cut off the extra bits, grind it, polish it, and sharpen it. Castings still have to have the same things done to them. Nearly all forgings and most pieces made from rolled, drawn, or pressed metal need some of the same operations. These operations are all called machining. The machines used for the work are called machine tools, and the place where the work is done is a machine shop. The terms machine tools and machining are ordinarily used only in connection with metalworking.



Courtesy Westinghouse Electric & Manufacturing Company

Machining a steel part for an electric motor. The man is smoothing it by grinding. The liquid running down cools the cutting edges of the machine and the object being ground.

Now and then the term machining is used for similar work on other materials.

Machine tools cut and grind metals as woodworking machines cut wood. On lathes, heavy forged axles are trimmed to perfect size and roundness. Screw threads are cut in a perfect spiral on parts that must be fitted together. Bits bore round holes—sometimes a number of holes at once. Rolls with sharp ridges plane off chips to smooth a surface. Power-driven chisels and saws cut off unwanted parts and gouge out grooves. Grinding tools sharpen and polish.

Some metals you can cut with a pocket-knife. Workers shaping the aluminum “skin” of an airplane cut and fit some of the pieces with shears worked by hand. Other

metals are cut quite easily with tools of ordinary steel. We need these softer metals and use them for a great many things; but the backbone of our industrial culture is steel. How can steel cut steel? That is where the alloy steels come in. You read about them on pages 158–163. Some of the alloys are called tool steels. The term means that they are used for machine tools to cut milder steels. Some machine tools have cutting edges of tungsten carbide instead of steel.

To understand modern techniques, there is a word you must learn. That word is *precision*. In our careless everyday language, we should say that every piece of a machine must be cut to precisely the right size and shape. A worker would say that such precision is impossible. Nothing can be cut to exactly the right measurements. For a job in which precise accuracy is not very important, the measurements may be off as much as a thousandth of an inch. For something that must fit really

well, a piece is discarded if it is not correct within a few millionths of an inch.

Perhaps the pictures on the next page will help you to understand the meaning of precision manufacture. At first glance you may think that the top picture is just a photograph of a pin. Now look again. To the left of the pinhead is a tiny white speck. The white speck is the important part of the picture. The pin is there to give you an idea of the size of the speck. Both objects are their actual size in the first picture.

In the second picture the pin and the speck are enlarged thirty times. That perfect little screw beside the huge pinhead is the speck you saw in the first picture. It will be used in a watch. A machine made it,

entirely automatically. The one in the picture is gold, but screws like it are made of steel.

A fine wire, drawn through diamond dies, is fed into the machine. The machine snips off a bit of wire. A metal arm catches the bit of wire, moves it a few inches, and holds it while microscopic tools work on it. The tools cut away the metal, shaping the point and the threads and cutting the slot across the top.

A great many large machine parts are cut with as much precision as that little screw. In building his first engines, Watt had to be satisfied if the space between piston and cylinder was no greater than the thickness of his thumb. No good engine could be made until parts could be machined more precisely than that. Inventors went to work to design better machine tools. They have been working from Watt's time to our own. Even now they are not satisfied, but today pistons fit engines so closely that burning gases under high pressure cannot escape between them. Mr. Watt's thumb would never go between them. Neither would the thinnest knife blade or the thinnest tissue paper. Only a slight film of oil separates the two surfaces to keep them from sticking. Remember that this perfect fit (within thousandths or millionths of an inch) is not just at one spot. The piston must slide up and down smoothly, and the fit must be equally precise all the way. That is an example of precision manufacture. Hundreds of machine parts must fit that closely and yet be free to move against one another.



It is easy to see that the pin was not made with precision, although that would have been much easier than cutting the tiny screw precisely. Pins need not be precise. A watch screw must be.



PUTTING THINGS TOGETHER

Everyone knows the story of how Eli Whitney invented the cotton gin. He made another invention later that is not so well known but is perhaps even more important. This time his invention was not a machine, but a method of working.

After teaching school for several years in the South, Whitney went back home to Connecticut. There he went into the business of manufacturing metal goods. A few years later he got an order from the United States government for a large number of rifles for the army. The rifles were to be completed within two years. Other manufacturers also had orders for rifles. Within a few months they began shipping rifles to fill part of their orders; but a whole year passed, and no rifles at all came from the Whitney factory. Finally the government appointed a committee to find out why Whitney was not making rifles.

He appeared before the committee—a group of severe and dignified gentlemen sitting around a long table. They asked for an explanation. Whitney said nothing, but he lifted a large bag to the table and poured out a heap of strange objects. There were ten rifle barrels, ten stocks, ten triggers—ten of each piece that goes into a rifle, plus a lot of little bolts and screws. Swiftly Whitney began to pick up pieces and put them together. In a few minutes he laid a complete rifle on the table. Then he put together another and another, until the ten rifles lay on the table. The committee members could not believe their eyes. Nothing like that had ever been done before. All of the members of the committee would have said it was impossible, but Whitney was doing it, right before their eyes.

Before that time, when a workman made rifles, he made one rifle at a time. Each part was forged and cut and ground to work with the other parts of that one rifle. The next rifle would work the same way, and in general it would look the same, but no part

would be precisely like the part in the first rifle. A part could not be taken from one and put into the other.

Whitney filled his order and had time to spare, although his workmen had not made any rifles for more than a year. They had spent that year making machines and patterns. Once the machines were properly made and set up, each machine could turn out an almost endless number of pieces, all exactly alike. Assembling a rifle, which simply means putting it together, took only a few minutes. When a workman needed a part, he reached into a bin and took the first one he touched. It was sure to fit because it had been made to precise measurements. In other words, the parts were standardized in size, and they were interchangeable. Any part would fit in any rifle of the same type.

On the Assembly Line

A process has to be broken down into simple steps before machines can be designed to do the work. Standardized, interchangeable parts are also necessary for large-scale production. Automobiles, airplanes, farm machines, electrical appliances, and thousands of other things are made of standardized, interchangeable parts.

Assembling automobiles. Many articles built up from interchangeable parts are put together on assembly lines. Probably you have seen pictures of an automobile assembly line. As the cars move along on a large conveyor, one part after another is added. Each workman has just one job to do as the cars pass him.

Automobiles are not “made” on an assembly line. They are only put together. Automobiles are made by miners and metallurgists; by blast-furnace workers and refinery workers; by workers at forges, rolling mills, wire mills, presses; by foundrymen and

machinists; by designers and draftsmen; by farmers and textile workers; by workers on a rubber plantation in Malaya, in a synthetic-rubber plant in Texas, in a rubber factory in Akron. Glassworkers, paint manufacturers, electrical workers, manufacturers of delicate instruments, and even woodworkers all contribute to the making of an automobile.

Automobile parts are made by all the metal-working techniques you have read about and others besides. Some are made far away from the plant where they will be put together. In the United States the center of the automobile industry is southern Michigan, but parts are made throughout Ohio, Indiana, and Illinois. Some are made still farther away. One automobile company in Detroit gets some of its parts from southern California, where the same company owns a mine and steel mills. Instruments are made in New England for automobiles assembled in Michigan.

An automobile starts with a design—just a picture on a piece of paper. The designer must be an artist, because people want their automobiles to be beautiful. He must also understand the materials that go into a car and know what can be done with them.

Next the engineers and draftsmen go to work. They must draw up specifications for every part. From roof to bumper, from frame to rearview mirror, from engine to hubcap, every part must be designed in exact size and shape. There is no almost accuracy here. The engineers give exact measurements, but they indicate how much *tolerance* may be allowed. In manufacturing, tolerance is the amount by which a part may vary from the exact measurement called for. If a part must fit within one hundred-thousandth of an inch, the engineers say so. Perhaps a tolerance of a thousandth of an inch will be enough. The closer the tolerance, the more difficult and costly the job.

The engineers draw pictures and cross sections with the necessary information lettered on them. Then the drawings are made into blueprints. Blueprinting is a

simple photographic method of making copies of a drawing. Hundreds of blueprints are necessary for an automobile, and a great many workers need copies of them.

Metals and alloys must be chosen for every part, and the method of shaping them must be decided upon. Then comes a stage of the process called tooling up, which may take months. Perhaps new machines must be designed to do some of the work. Certainly there must be new dies and patterns. The purchasing department places orders for raw materials and for finished parts. It even orders the fabric and stuffing for the upholstery, the covering for the floor, the glass for the windows, and all the knobs and buttons and dials and switches that go into a finished car.

In factories far away and near, manufacturers begin to prepare the parts. Perhaps they, too, must draw designs and make blueprints, shape new dies and patterns, make models and try them out. Finally the materials and parts that have been ordered begin to come to the automobile factory. Materials are cut or shaped or put together to make parts. The parts are distributed so that each worker has the pieces he needs and the tools he needs for his highly specialized job. Then at last the assembly line begins to roll. It would not roll an inch if hundreds of other workers had not finished their tasks first.

The amazing thing about the assembly line is not the speed with which a car can be put together. We take the most marvelous fact for granted in our precision-built world. Every part fits. A part may have been made in West Virginia or Wisconsin, in Connecticut or California; but when the Michigan assembly-line worker picks it up, it fits exactly. The automobile assembly line is Eli Whitney's dream come true.

Trucks, tractors, and other farm implements are usually put together, like automobiles, on assembly lines. Large airplanes are not. Parts are put together first. Then cranes carry the finished parts to a spot

where a crew of men rivets or welds them together. Locomotives and railway cars are put together the same way. So are most large pieces of machinery. A few trains and machines are custom-built; that is, the company ordering them wants just one or a few pieces of equipment according to its own design. Then mass-production methods cannot be fully used, but the pieces are usually designed so that they can be formed on standard machines by standard methods.

Only a very small percentage of factory workers are actually on assembly lines of the kind used in automobile factories. The term assembly line has come to be almost a symbol, however. We speak of assembly-line methods of manufacture even when there is no actual assembly line. The term stands for the work in any industry in which there is a high degree of division of labor and the work is passed on from worker to worker.

Assembly without an assembly line.

The shoe industry is a good example of one in which assembly-line methods are used without an actual assembly line. A highly skilled cutter cuts out pieces for the uppers of a pair of shoes. He cuts by hand, with a knife, around metal patterns. The pieces

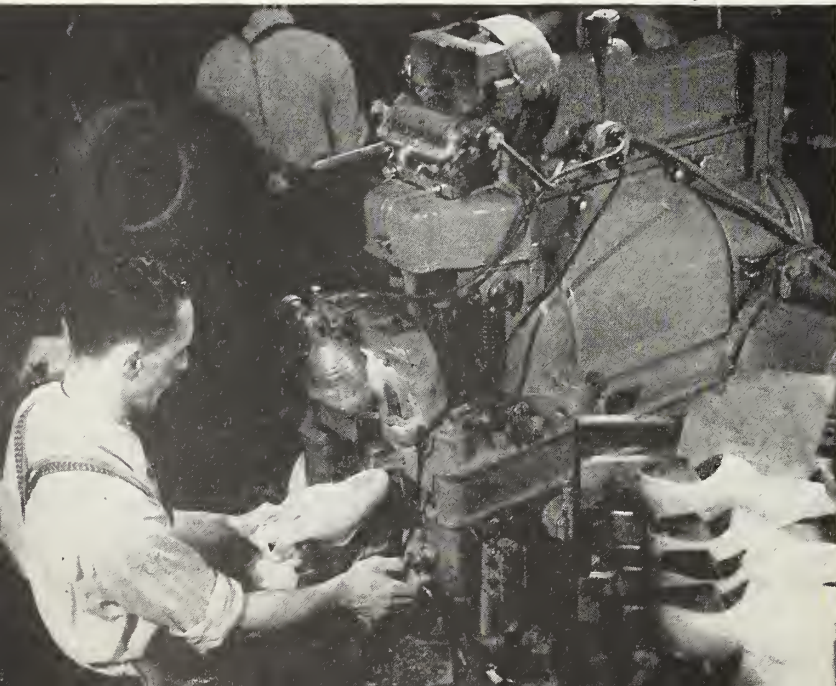
are fastened together with pieces of cloth and leather for lining. Those pieces will stay together all through the making of a pair of shoes, for no two skins are exactly alike. The appearance of the shoes would be spoiled if the workers assembled pieces from several skins.

The pieces for a number of pairs of shoes are put together on a rack. The rack goes first to the sewing room. There long rows of workers, mostly women, sit at sewing machines. Each worker gets a whole rack of shoes. She has only one or two seams to sew, but she sews those seams on one pair after another. When she has finished all the shoes on one rack, she gets another and sews the same seams on all the shoes on that rack. The first rack is pushed to a row of women who sew the next seams.

When the uppers have been sewed together in this way, the same rack of shoes is taken to another department, where each shoe is stretched into shape over a wooden last. Then the insoles, soles, and heels are put on. Each worker in a shoe factory has just one job to do. The shoes pass on from one worker to another, but not on an assembly line. They are not made of interchangeable parts, either.

Running a machine that nails the upper part of the shoe to the insole at the heel. The workman looks at heels eight hours a day.

Courtesy Thom McAn Shoes



Ready-made clothing is usually manufactured by the same methods as shoes. Many pieces of a given size and design are cut out, and the garments are passed along for sewing. A worker usually sews more than one seam. Perhaps one worker does all but the finishing on a garment.

For an industry that has only a touch of assembly-line methods, we might go to a watch factory. A watch is not passed on from one workman to another for assembling. There is division of labor only in making the parts.

In the story of the screw on page 257, you saw how one watch part is made. This tiny object is

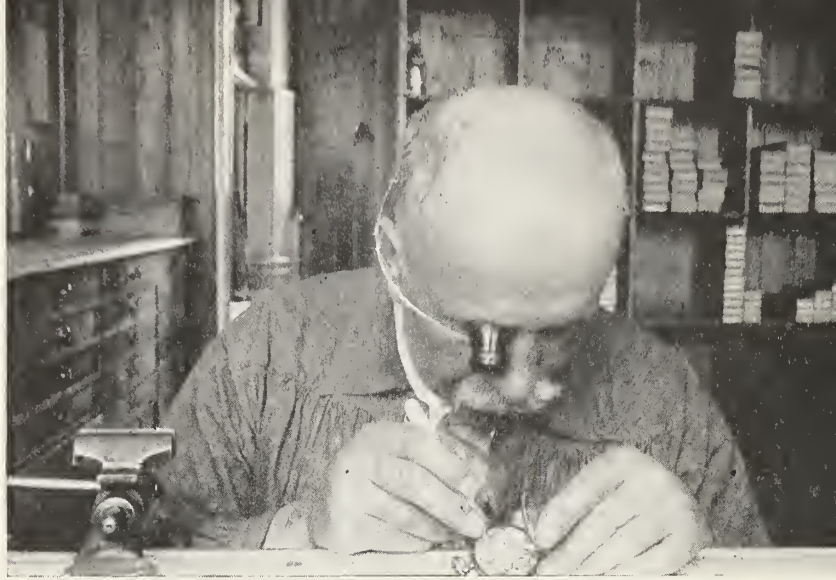
one of the smallest parts in a watch, but all are made with equal care. Perfect little gear wheels are stamped from brass or steel. Part of the time-regulating mechanism is the hairspring made from nickel steel drawn through diamond dies until it is much smaller than a real hair.

All the parts are made ahead of time in different departments. In Switzerland, world-famous for fine watches, many parts are made at home. A farmer has one electric-powered machine, which he operates when he cannot work on his farm. Thus there is division of labor in making the parts of a watch, as you see. Parts for the same style of watch are interchangeable, for they are made on precision machines and they are all just alike. When it comes to putting the watch together, one man or woman does the work.

A worker has little boxes of parts—many of each part. The watchmaker works on a little plaster block with a hollow in the top that fits the works of the style of watch he is making. He works with a magnifying glass fastened to his eye, and some of his tools are too small even to be toy tools. Imagine the screwdriver needed for putting in the little screw in the picture!

Artists and Craftsmen

In ancient times and during the Middle Ages, every manufacturer was a craftsman. He made one article at a time, with only simple tools and machines. If he was a good workman, his wares were soundly made. If he was a poor workman, they were poorly made. If he had artistic ability, the design was good. If he had no artistic ability, the design was bad, unless he was copying a pattern set by someone else. In nonindustrialized parts of the world there are still craftsmen who make articles of



Central Feature News

Have you ever seen a watch repairer wearing a magnifying glass over one eye? This Swiss watchmaker uses one to see the tiny parts in the watch he is making. There are about 150 parts.

everyday use. They do not work entirely without machines, but their machines are simple and are worked by hand or foot power.

We still like to have some things that are made by hand or with simple tools. We like to have a few things that are not made by the million, all alike. That is why there are still dressmakers and tailors, in spite of all the factories manufacturing ready-made clothing. That is why we like pictures that artists have painted and why every tourist who goes to Mexico brings back handmade silver jewelry.

One large manufacturing industry is still largely a handicraft. That is the making of furniture. Except that lathes and other machines are now run by power, most fine furniture is still made by methods used two or three hundred years ago. In addition to a few power tools, furniture makers use handsaws, planes, and knives. They shape each part to fit and build a piece of furniture by hand. They smooth the surfaces by long rubbing with sandpaper. They paint or varnish or wax the pieces by hand and spend hours polishing them by hand. If the furniture is upholstered, they cut the fabric and put it on by hand.



Central Feature News

Danish silversmith making silver pieces by hand. The sauceboat at the left is copied from a famous model now in a museum.

Those are the techniques that are used for making good-quality furniture of wood. Most people still like such furniture best, but mass-production methods are beginning to come into the furniture industry. Today furniture is being made of plywood that is pressed into shape. Then, too, several companies are using metals, glass, and plastics that are shaped by the methods generally used for those materials.

Handwork in the making of furniture. The man at the front is sanding the bottom of a drawer so that it will slide easily.

Courtesy West-Dempster Co.



The Building Industry

The building industry, too, is still carried on largely by handicraft methods. Of course the materials that go into a house, a factory, or an office building are made by mass-production methods, but these are only the raw materials of the builders.

Building a house. A house starts with an architect's plan. The plan is blueprinted so that each worker who needs a copy can have one. Then a contractor is hired. He knows how much will be needed of each kind of material and where to get it.

He also knows what specialists to hire to do the various kinds of work.

Directed by the contractor, workmen come, crew after crew. Men with bulldozers and power shovels dig the basement. Cement workers put concrete walls and floors in the basement. If the house is to be built of brick, bricklayers lay up the walls brick by brick. Carpenters put up the frame and the inside woodwork. They get boards and timbers in different sizes from the planing mill, but they saw them to fit on the spot and nail them into place with hammers. Carpenters put in the hardware, too, such as locks and hinges.

Inside the house, electricians do the wiring; plumbers put in the plumbing; heating experts install the furnace and all that goes with it; gas fitters put in the gas pipes; men from the telephone company install the telephone wires; plasterers plaster the inside walls; and decorators paper the walls and paint or varnish the woodwork.

Large buildings, too, are put up piece by piece. The work is

more highly mechanized than in building a small house, but skilled workmen do their part of the work largely by hand. As in building a house, they follow an architect's plan, under the direction of a contractor.

Building with steel. Every large modern building has a strong steel skeleton. It is made of beams rolled into their finished shape on rolling mills. The beams are of standardized size and shape, but they are put together by hand, beam by beam. There are mechanical hoists for lifting the beams and swinging them into place. Then crews of riveters fasten them together.

Usually the steel framework is covered with concrete. First, wooden forms like long boxes are built, with the beams running through the center. Then workmen mix cement with sand, gravel, and water in a mixing machine. The wet concrete, raised on a hoist, is poured in, filling the forms. It sets and becomes as hard as rock.

Around this framework of steel and concrete, masons lay up walls of brick or stone. Other crews of workmen add the same kinds of equipment they would put in a house. In addition, specialized workers may install sprinkler systems to be used in case of fire, air-conditioning equipment, special kinds of flooring, and any other equipment called for by the use to be made of the building.

A variety of structures. Probably you have heard of prefabricated houses. Maybe you even live in one. That curious word means just about the same thing as ready-made. A few companies have made whole houses to be hauled to buyers' lots on trucks and set on prepared foundations. Generally, though, a prefabricated house is not quite so ready-made as all that. What the buyer gets is sections of walls, floor, and roof that are complete and need only to be fastened together. Whole bathrooms and kitchens come ready-made, needing only to be set in place and have their pipes connected with the sewer, gas main, and water main.

In the methods used, building a ship lies somewhere between the assembling of an automobile and the building of a house. Most materials come to the shipyard already cut and shaped to specifications. All large, modern ships are made of steel plates which come to the shipyard already rolled and shaped. The engines and other machines are complete, ready to be set in place. Building a ship is a little like building a factory on skids so that the whole thing can slide into the water when it is finished.

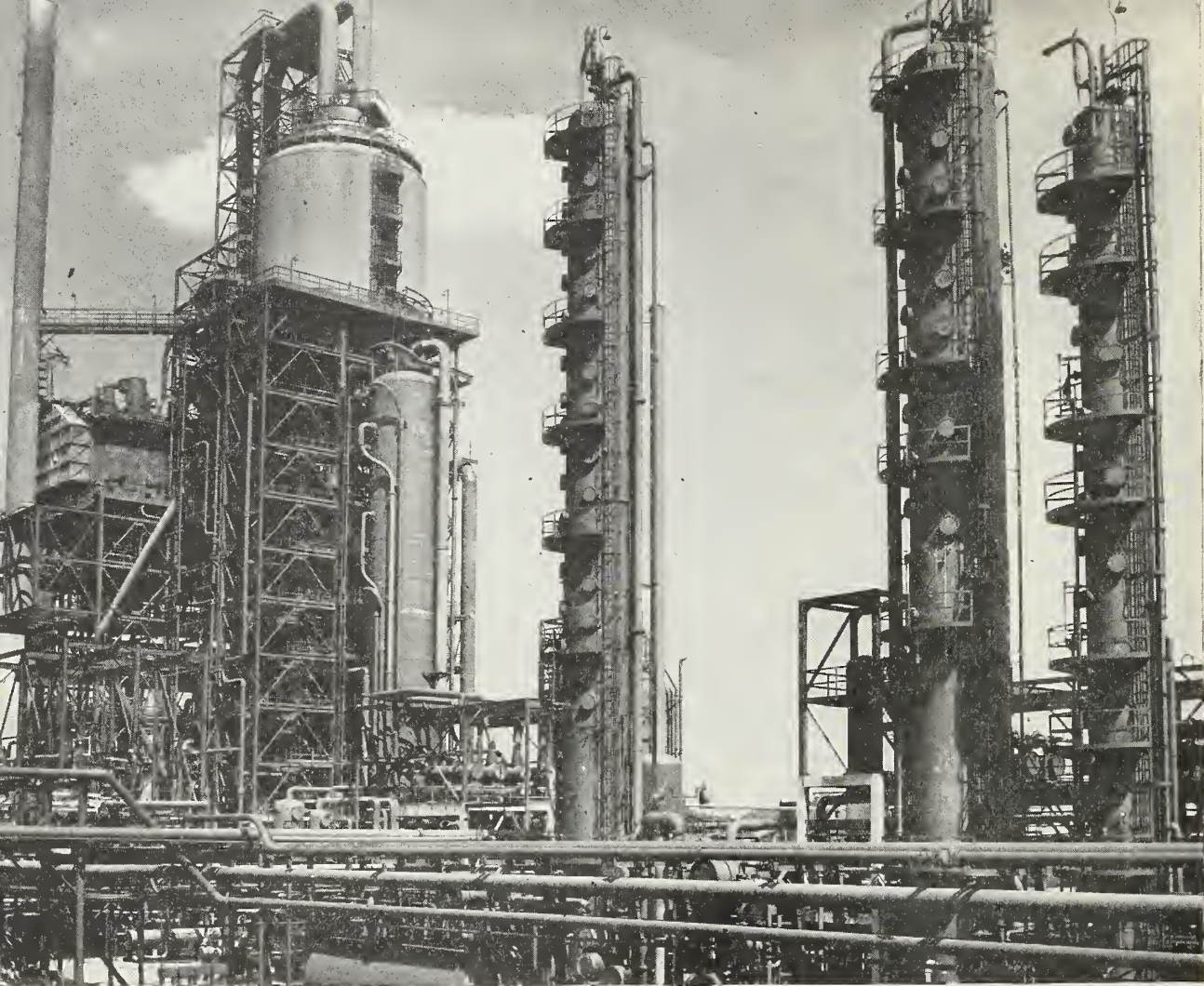
If you were to travel over the country, you would see many strange-looking factories. They look like tangles of pipes wound around tanks, towers, and curiously shaped furnaces. A few ordinary buildings scattered here and there seem small and unimportant among the shapes that are like something you might dream in a nightmare.

Putting together those remarkable structures is not much like building a house or a bridge. It is more like setting up the equipment of a gigantic laboratory. The picture on the next page will give you an idea of how such plants look.

Putting Together Chemical Products

The plant shown in the picture on the next page is an oil refinery. The names of the structures are as strange as their appearance. The three slender objects at the right are bubble towers. At the left is a still stranger structure with a still stranger name—a catalytic cracker. You will have to go to high school and study chemistry before you understand the name or what goes on inside the structure, for refining oil is a difficult chemical process.

By the use of such equipment as you see in the picture, and other kinds, too, substances can be broken down and taken apart chemically. Some are broken down to the atoms of the elements that make them up. Then these atoms can be forced to unite in different ways to form entirely new compounds.



Courtesy Standard Oil Company (N. J.), photograph by Collier

An oil refinery in Baltimore, Maryland. The catalytic cracker at the left rises above the bubble towers.

Products from oil and coal. What goes on in the bubble tower is comparatively simple. At the bottom of the bubble tower the petroleum is heated until it boils away. There are technical terms for the process, but the more familiar words describe it. The hot compounds that make up the petroleum become gases and rise in the tower. Each substance in the petroleum has its own boiling point. Raise the substance above its boiling point and it will turn to gas. Cool it below its boiling point and it will become a liquid again. The petroleum is heated to a temperature that will turn all the liquids to gas. As the gases rise, they come to cooler and cooler sections of the bubble tower.

Some of the compounds have a very high boiling point. Near the bottom of the tower, they are cooled below their boiling point and turn back to liquid. The liquids are drained off to become lubricating oils and waxes such as paraffin. A little higher, other compounds go back to liquid form. They are the fuel oils. Still higher in the tower, liquid kerosene is drained off. The gases that reach the very top of the tower make up gasoline.

Now for that catalytic cracker that you are just not going to understand. Some of the oils from the middle section of the bubble tower flow into it through pipes. It breaks down some of the chemical compounds so that parts of the oils become gasoline. We

need gasoline in greater quantity than other petroleum products. The cracking process provides more gasoline from the same quantity of petroleum.

Chemical compounds can be taken apart. They can also be put together. Compounds can be broken down to their separate elements and those elements built up into new compounds. In recent years, chemists have been able to build up some very complex and valuable materials that do not exist in nature at all. Building up a chemical compound is called *synthesis*, and the products made by this method are called *synthetics*. One of the most important is synthetic rubber.

Synthetic rubber can be made in several different ways. The method most common in America uses petroleum products as raw materials. Some of them come from the catalytic cracker, along with gasoline.

Another large group of synthetics are, in a way, by-products of the steel industry. Do you remember the coke that goes into the blast furnace? Steel plants are the largest users of coke, and most steel companies make their own. A large steel plant has a long row of coke ovens. In them coal is heated very hot, but it is not burned.

Like petroleum, coal is made up of many different chemical compounds. Some of them are the same as the compounds in petroleum. In fact, gasoline can be separated out of coal as well as extracted from oil. The process is more difficult and costly. It is little used in countries that have plenty of petroleum, but it is used in a number of European countries that have coal, but no large oil deposits.

The steel companies do not want gasoline, however. They want coke for their blast furnaces. Coke from good coking coal is almost pure carbon. It is the part of the coal left after heat has driven off everything that can be turned into a gas. Some of the gases are good fuel. Coal gas can be used like natural gas, although the chemical composition is not the same. Steel companies use the gas for heating their furnaces.

If they have more than they need, they may sell it to other industries or to neighboring communities for cooking and heating fuel.

Oils and coal tar are other by-products of the coke ovens. From these are taken many chemicals that are the raw materials for synthetic products. Again, you need to have studied chemistry before you can understand the process.

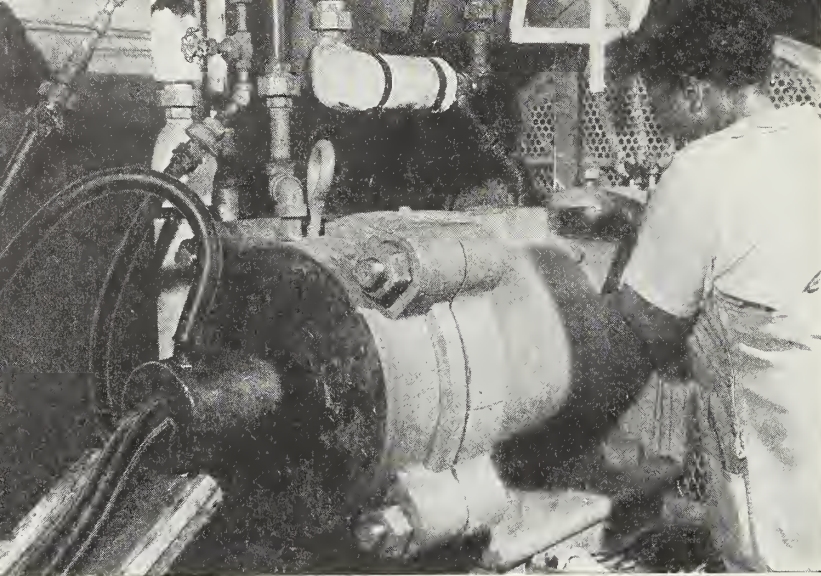
In 1856 an eighteen-year-old English boy discovered that dye could be made from coal-tar chemicals. Now nearly all our dyes are coal-tar products, but dyes are only a beginning. Perfumes, many drugs used in medicine, ammonia, and raw materials for other products are derived from coal tar.

Plastics and synthetic textiles. Many synthetic materials belong to a group that we call plastics. For some of them cellulose is the principal raw material. Cotton fibers are almost pure cellulose. So is chemical wood pulp. Both of these materials are a base for plastics. The same products can be made from either one. When cotton is used, it is generally linters, the tiny fibers that still cling to the seed after it has gone through the gin. They are too short to spin and, in earlier times, they were wasted.

The following description tells you a little about one process for making cellulose plastics. There are others. The cellulose is treated with chemicals that make it crumbly instead of fluffy. Then it is put into a mixing machine with chemicals that will dissolve it. If the finished product is to be colored, dyes are added. The mixing machine is warmed by steam in pipes.

After metal blades inside the mixing machine have churned the materials for a time, they look like gelatin. They are translucent if they have not been colored or if the color is light. They feel slightly warm and a little greasy. The newly made plastic is then kneaded on a roll mixer like the one in the picture on page 240.

There are various ways of shaping the plastic. Some of the spongy sheets from the



Courtesy Du Pont Company

The operator of this machine is feeding strips of heated plastic into one end of it. At the end nearer you three plastic rods are being extruded from the press.

mixing rolls are piled up in a stack. The stack is then heated and pressed. It comes out a solid block, which is sliced into sheets on a machine. Some of the material from the mixing rolls is fed into machines such as the one you see in the picture on this page. It is an extrusion press. The process is much the same as the extrusion of metal.

Three rods at once are being extruded from the press. As a rod comes out, it is warm and limp. A workman cuts it in measured lengths and lays the pieces on a flat table. As they cool, they become hard and stiff. The translucent brownish handles you have seen on screwdrivers and other tools are made from such rods. Other presses extrude tubes that are used for making the barrels of fountain pens and many other articles.

Other types of plastics are produced in the form of powder that can be molded in presses. Some of the molded plastics are mixed with ground wood, asbestos fibers, or other fillers. Many automobiles have brake linings made of asbestos-filled plastics. Plastic materials may be soaked into fabrics. Layers of the plastic-soaked fabric are squeezed together in hot, powerful presses. When cooled, the material is almost as strong as steel. Gear wheels for machines are cut

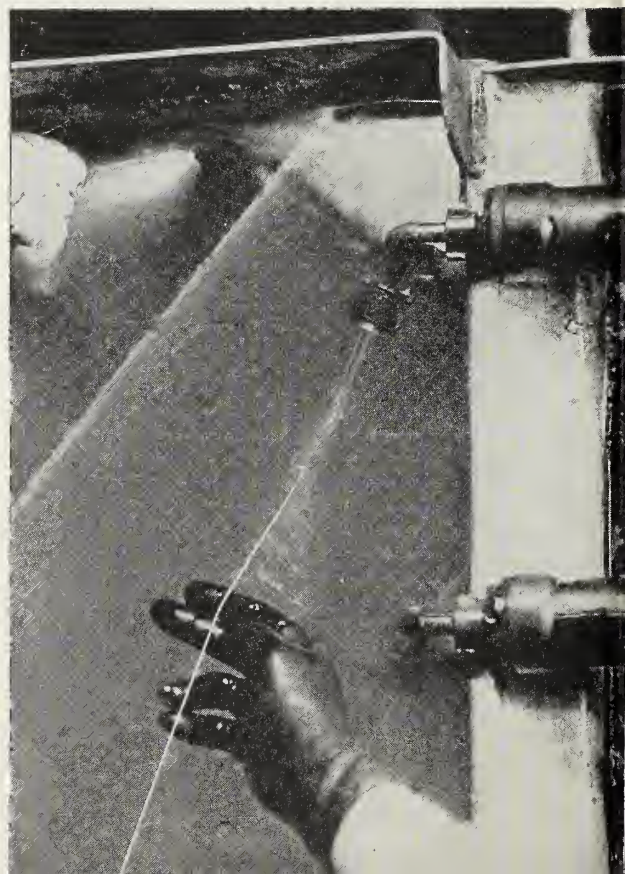
from it. Cellophane is a plastic product made in large quantities. Hundreds of everyday household articles are made of plastics. You probably have a number of them at home.

By varying the chemical composition, the plastics manufacturers can produce plastics in liquid form. Some of these plastics are used in paints and varnishes. Others are used to bind materials together. The waterproof glues used in plywood and laminated wood belong to the plastics family of materials.

Synthetic textiles, too, belong to the plastics family. Those made with a cellulose base have the general name rayon. The cellulose is dissolved in chemicals and becomes a syrupy liquid. The picture shows how the liquid is

This picture was taken above a tank of sulfuric acid solution. At the top you see liquid cellulose spraying into the acid. Like magic, it hardens and becomes rayon thread, as seen at the left.

Courtesy Du Pont Company



made into filaments for textiles. It is extruded through tiny openings into a tank filled with a sulfuric acid solution. In the acid, the thin filaments harden at once.

Another synthetic, nylon, was developed during the 1930's. The chemicals synthesized to make it are taken from coal, air, and water. When people think of nylon, they usually think of knitted nylon fabric for women's hosiery or woven nylon cloth. The first nylon sold, however, was in the form of toothbrush bristles. Bristles for brushes are still one of the most important products for which nylon is used. Also, heavy strands of nylon are used instead of wire for window screen. Combs and other articles are molded from it. Nylon filaments for yarn are formed in the same way as rayon filaments.

There are other synthetic materials—many of them. More will be discovered, and new techniques will be invented for shaping and using them. Most of the synthetic materials we have are very new, compared with metals and vegetable fibers. The chemists work with coal, oil, common earth materials, and farm products. Milk furnishes raw materials for a whole series of plastics. Soybeans supply chemicals for many synthetics. Oat hulls and corncobs go into chemical manufacturing plants and come out useful products. These farm wastes are even used as a source of chemicals for synthetic rubber. Many people believe that farm products should be used for this purpose instead of petroleum products. Can you think why?

A WORKSHOP ON MANUFACTURING

This book does not have room to tell you all about manufacturing. There are so many processes and so many products that no one in the world knows all of them. Since you cannot possibly learn all about all industries, you will need to choose a few for special study. Read the whole chapter for general understandings about manufacturing and for new words you need to know, but spend most of your time on industries that interest you most. These will probably be industries of your community.

Your Community as a Laboratory

Almost every community has factories of some kind. Almost every community produces raw materials for industries. Every community has workers who are makers or builders of something useful. Get acquainted with a few of these people. They will be glad to tell you about their work.

MANUFACTURING AT HOME

If you had lived before the Industrial Revolution, you could have seen many kinds of manufacturing without leaving home. As machines were invented, one industry after another moved from homes to factories, but

you can still see work being done at home. Food is still processed in almost every home. Learn to do some cooking yourself. That is an excellent way to study food processing.

With all the ready-made clothing there is today, sewing is still done in a great many homes. Find out what knowledge and skills a person must have to be able to sew well.

Cooking and sewing may be the only processes you can see at home, but you can see others in your community. Probably each of you knows someone who can show you a few industrial techniques and processes. For example, plumbers, workers in an automobile repair shop, watch repairmen, the man who makes keys at the hardware store, and many other people know some of the techniques of metalworking. Many people do weaving, metalworking, or clay modeling as a hobby. If you know any such people, they are good ones to consult.

THE INDUSTRIES OF YOUR COMMUNITY

Study the factories of your own community. Find out:

1. What products they make.
2. What raw materials they use and where they get them.

3. What kinds of fuel and power they use.
4. What kinds of machines and other equipment they have.
5. What techniques they use.
6. Whether the products are sold mainly in your own community or are shipped away.
7. The exact jobs of as many workers as possible.
8. The importance of each factory to your community. Does your community depend largely upon one industry, or are there many? What would be the effect upon your community if each industry were not there? You cannot find an exact answer to that, but it is an interesting question to discuss.

MATERIALS FOR INDUSTRY

Perhaps you live in a community that has little or no manufacturing. In that case, you may spend most of your time studying the importance of your community to industries in other places. Every community produces useful goods of some kind. Find out all you can about the products of your community, where they go, and what is done to them to prepare them for use.

FAMILY NAMES

Were any of your ancestors craftsmen during the Middle Ages? There is a way you may be able to tell. During the early Middle Ages only a few families had surnames (family names). Most people had only what we call first names. Of course many people had the same name. A way had to be found to distinguish between them. One way of doing this was by adding the father's name. A community might have a Thomas, John's son; and a Thomas, William's son—or Thomas Johnson and Thomas Williamson. There might also be a Thomas Hill, because he lived on a hill. Another common way to distinguish between people was by occupation. A community might have Thomas the Weaver, Thomas the Smith, and Thomas the Miller.

Then it became the custom for each family to have a surname. Finally laws were passed requiring people to have surnames. Most of them kept the names by which they were ordinarily called. In the next column is a list of common occupation names. If your name is in the list, you must have had an ancestor who worked at the occupation

it stands for. There are a few other less usual ones, also. The names in the list are all English. If your name is from another language, it may be the name of an occupation in that language. Ask your parents if they know the meaning of the name.

Here is the list: Arkwright, Baker, Brewer, Brewster, Butcher, Carpenter, Cartwright, Chandler, Cook, Cooper, Coppersmith, Currier, Cutler, Farrier, Fletcher, Fuller, Glazier, Glover, Goldsmith, Hatter, Mason, Miller, Plumber, Potter, Saddler, Shoemaker, Smith, Tanner, Taylor, Turner, Wainwright, Weaver, Webber, Webster, Wheelwright, Wright.

Smith is the most common name in America, not even counting the names from other languages that mean the same thing. There are also Coppersmiths and Goldsmiths. Cutlers and farriers were also specialized smiths. A cutler was a knife maker, and a farrier was a horseshoer. Webber and webster are other names for weaver. Wright is a general term for a man who builds or makes something. Cartwright and wheelwright you can understand. An ark was a box or chest, and wain is an old-fashioned name for wagon. A chandler was a candle-maker, a cooper made barrels, a currier was a leather finisher, a fletcher was an arrow maker, a fuller was a cloth finisher, a glazier was a glassworker, and a turner was a man who worked with a lathe. A plumber was a man who worked with lead, not one who installed sinks and bathroom fixtures.

Which occupations named in the list no longer exist? Why do you never find anyone named Machinist, Engineer, Canner, Electrician, or Aluminumsmith?

Test Your Skill and Knowledge

This chapter has many dates of inventions and new developments in manufacturing. You are not expected to learn those dates. They are given you so that you can understand how our modern world of mechanized industries came to be. Add the dates to the time chart you started when you studied the chapter on power. Draw a second column on the chart for the dates from this chapter. You will understand the Industrial Revolution better when you see the dates from the two chapters side by side. You will see how each new invention depended upon earlier inventions and led to later ones.

USE YOUR TIME CHART

Here are a few questions to discuss, with your time chart before you. The questions are hard, and you will have to think.

1. Could industry have been mechanized during the eighteenth and nineteenth centuries if there had been no sources of power except animals and the two kinds of old-fashioned water wheels?

2. What inventions in your power column had to come before the invention made by Hall and Héroult?

3. Would huge factories have been possible without the invention of the Bessemer converter and the open-hearth furnace? Be ready to give reasons for your answer.

4. As fuel, King Solomon's metalworkers used charcoal brought many miles on the backs of camels. If one of his metallurgists had built a modern blast furnace, it could not have been used. Why not?

If you wish to continue the discussion, you can find other questions for yourself.

YOU ARE A CONSUMER

Everyone is a consumer of goods. The more you know about products and techniques, the more intelligent you will be as a consumer. You might divide up the following jobs among members of the class and let each one report on what he learns.

1. Read the labels on cans and packages. Find out what the maker tells you about his own products. He is required by law to name the ingredients. He probably tells you the weight of the contents. He may also give you recipes, instructions for cooking, and other interesting information.

2. United States law requires manufacturers of woollens to label their products. Find out what the labels tell you. Other textiles may also have labels that give you information.

3. Examine textiles for yourself. Get many small samples and cut them to exactly the same size, say one inch square. Count the number of yarns. Try to discover the weave pattern. To make patterns in the weave, weft yarns may go over or under several warp yarns instead of just one.

4. Learn to recognize the common metals. Get samples of some of them. Your samples

may be broken or worn-out objects and articles of very small value, such as pins and paper clips. Examine each object carefully to find out what techniques were used in manufacturing it. Test the metal for yourself by hammering, bending, and filing. If your school has a metal-working shop, you may be able to try other experiments.

5. You cannot make a casting of iron or steel or brass, but you can make one of a material that is very easy to handle—paraffin. Besides the paraffin, you need two small pasteboard boxes of the same size and a supply of sand. Moisten the sand and fill the two boxes with it. The sand must be moist enough and packed tightly enough to stay in when the boxes are turned upside down. The boxes are your flask. Cut a small hole in the box that is to be the top of the flask.

Use any small, simple object for a pattern. A large button makes a good pattern. Lay it on the sand in the lower half of the flask and press the upper half firmly down on top of it. While the pattern is still in the flask, work a small rod, such as an unsharpened pencil, down to the pattern. Make sure a clean channel is left from the outside of the flask to the pattern.

Now lift off the upper half of the flask very carefully and remove the pattern. Put the two halves together again, and your flask is ready for pouring off.

Melt the paraffin and pour it carefully into the opening in the flask. Watch the opening for a few minutes and add more paraffin if what you have already poured sinks down from the top of the channel. Give your casting plenty of time to harden before you open the flask.

Do you see why a casting must be machined? Probably your casting looks quite rough. With practice you could make a better one, but real castings in a foundry are rough, too. The extra material must be cut away and rough surfaces smoothed.

6. Soak various kinds of paper in water and separate the fibers with a pin. What differences do you find between the fibers in, say, a piece of writing paper and the fibers in a pasteboard carton? What differences between kinds of paper did you discover when you tried to soak your samples?

7. Find out what articles in your own home are made of plastics. Makers of plastics would like people to know that plastics

are not good for everything. They say that sometimes manufacturers use plastics in ways that were never intended and that the results may be unsatisfactory. Have you ever had any articles made of plastics that broke, wore out, or melted when you tried to use them? Why do you suppose the plastic makers want people to know that their product cannot take the place of other materials for some purposes?

WHAT IS AN INDUSTRIAL REGION?

In this book and in your earlier geography texts you have read about industrial regions. Industrial regions are drawn on the map at the beginning of this chapter. Perhaps you have not understood fully just what an industrial region is or how it can be given boundaries on a map.

You can find out for yourself what the term "industrial region" really means. This is not a job for every member of the class. It is a specialized job for a few of you who like to draw maps.

First look at the map on this page. It shows the distribution of the people who work in manufacturing industries. On an outline map of the United States, draw a line around the areas that have the most people in manufacturing. Do not try to put on the scattered dots. Just draw lines outlining the black areas on the map on this page.

The manufacturing population map alone is almost enough to define the industrial areas, but you can add greatly to your understanding by adding more lines to your map.

Turn to the eight industry maps on page 206. Using a different color for each one, add to your map the regions in which those eight industries are important. Where the dots are thick, draw a heavy line around the whole area. Forget the scattered dots.

Your finished map is a tangle of lines in some places, isn't it? Where there are the

most lines, you have an industrial region. If you had more industrial maps than the eight on page 206, you would have a still more complex tangle of lines on your map.

What you have really done with your map is build up a generalization from detailed information. All generalizations are built up by putting together many details.

DO YOU UNDERSTAND THE NEW TERMS?

1. Would you use a mechanical or a chemical process to crack a nut? To crack petroleum oils for gasoline?

2. Would you use the technique of forging to shape cast iron, heat a blast furnace, shape steel, or put the lid on a can?

3. Have you used any ceramic products today? If so, where and for what purpose did you use them?

4. Would you use a machine tool to build a house, make a shoe, manufacture a plastic tube, or cut metal?

5. What synthetic material might you use in an automobile tire? a toothbrush? clothing?

6. Which requires the greater precision in manufacture, a part that must fit within a hundredth of an inch or one that must fit within a thousandth of an inch?

7. In which of the two products is a greater tolerance allowed?

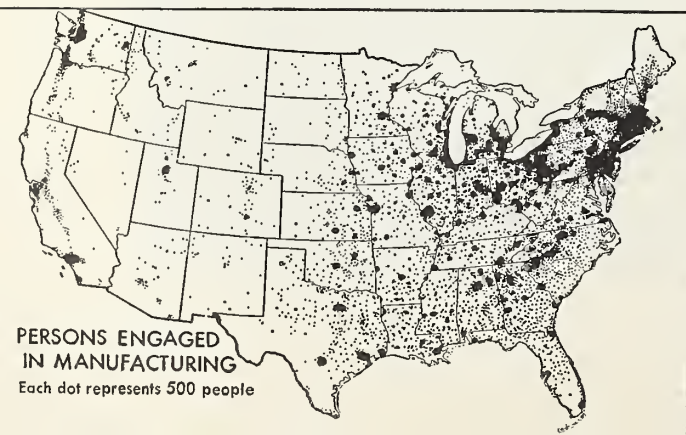
8. If you used a forced draft, would you be using force on metal, air, water, or machinery?

9. A foundry worker uses molds. Is he a cheese maker, a metalworker, or a worker in ceramics?

10. A workman loads a machine with metal rods and turns on the power. In a moment a stream of small metal articles drops out, finished and ready to use. The worker at the potter's wheel in the picture on page 241 holds a tool against the clay to shape a dish as the wheel turns. Which workman is using an automatic machine?

ADDITIONAL INFORMATION

A great many manufacturers have booklets, samples, and other materials they will be glad to send you. You can find the names and addresses of manufacturing companies in advertisements, on goods in the stores, and from your community storekeepers.





Transportation and Communication

PIONEERING THE EARTH

How far is it from your home to a good transportation route? Look at the map at the top of the page. The lines on that map stand for belts of land about twenty miles wide along the railways of the world. If you live in one of those belts of land, you are within easy reach of a railroad.

Compare that map with the American population map on pages 374–375. Most of you who read this book do live in those belts of land, because the areas that have the most people have the most railroads. In the really densely populated areas there is no space at all between the twenty-mile belts within which no one lives more than ten miles from a railroad.

Railroads are not the only means of transportation. Air lines and paved highways are part of the world's land-transportation

system, but the areas with the most railways also have the most airfields and roads.

Outside of the areas in which the lines on the map form a solid network, there are railroads that stretch away through sparsely inhabited regions. Highways and air lines, too, stretch out to the remote parts of the earth. On the ocean no one needs to build highways. People need only build ships, for ships can go wherever there is open water. No matter where you want to go in the world, you can have good transportation most of the way by ship, railway, road, or air. For most journeys, you have a choice of several means of transportation.

We think we could not travel without trains, automobiles, ships, or airplanes. But people traveled over most of the earth without any means of transportation. At

least, they traveled without anything that we should consider a possible means of transportation for distant travel.

Long before there were any historical records, people lived almost everywhere in the world that people live now. The population was very sparse, to be sure, but however thinly they might be spread, people were scattered over nearly all the inhabitable parts of the earth. How did they get there?

There have been many arguments about where the first people lived; but nearly all scientists agree that at some long-ago time the ancestors of all the people in the world today lived in one small area, probably somewhere in Asia. From that one small area people traveled to all the rest of the world. They made their long journeys before they had even horses to carry themselves and their goods.

How did people spread over the earth? The only possible answer is that they must have walked. From somewhere in central or southwestern Asia they must have walked to the Atlantic shores of Europe, to South Africa, to the southern tip of South America. Perhaps you think they could not have walked all the way to southern South America because the Americas are surrounded by water. Most anthropologists, however, do

believe that the first people in America walked all the way. First they walked to northeastern Asia. In an unusually cold winter, they crossed to America on a bridge of ice. Then they walked south until they came to the southern tip of South America.

They did not start out to walk to the southern tip of South America, of course. None of these early people started out to walk anywhere. They were hunters. As you read on page 25, among hunting people each family needs a large area to supply it with food. The population could easily become too dense for the food supply. One family of grown-up children and grandchildren would be too many people to live in one place. Some of them had to find new hunting grounds. Some might find them near by. Some might have to wander a long way.

Animals migrate. No doubt whole tribes of hunters followed herds of migrating animals. Climates change over long periods of time. Probably some people moved out of regions that were becoming too dry or too icy for plants to grow. Where there are no plants, animals cannot live. Where there are neither plants nor animals, people cannot live. The search for food led people over the earth, always to new hunting grounds.

ON ANCIENT HIGHWAYS

Those first travelers over the earth had no highways at all. Probably they followed streams many times, because valleys are the easiest routes of travel through rough country. When they came to a wide or very swift river, they followed it for a way until they came to a place where they could ford the river, or at least swim across it.

When the next band of migrating hunters came the same way, they probably followed the same routes for the same reasons. The way that looked promising to the first group of travelers looked good to the next group also. No one marked a route so that he

could find his way back, because no one expected to go back. But without any planning or intention, group after group of people did follow the same route, probably because it seemed like the best one.

The First Roads

The first roads in the world were paths worn by human feet. After a group of people had settled in a region, they explored it for resources they could use. In one place, the hunting was good in the summer; in another place, it was better in winter. Nuts

ripened on the hill in the fall; in spring, fishing in the river was good.

As people went out to hunt or gather food, they walked where the walking was easiest. The next time they went, they walked again where the walking was easiest. Before long they wore a path, just as you wear a path across a vacant lot or a field.

As groups of people began to live closer together, they went visiting sometimes. They began to trade a little. Almost always they walked where the walking was easiest, and their feet wore paths.

Indian trails, which were paths, crisscrossed North America. Pioneer settlers followed those Indian trails, first on foot or on horseback, and then with wagons. Usually the Indians had found the best route. Even today many of our roads and railroads follow the routes of the old Indian trails. All over the world today, there are modern routes of travel that follow paths first worn by the feet of primitive people who walked wherever they went.

Ancient land transportation. Some of those ancient foot travelers carried loads on their backs. They carried home food they had captured or gathered. On longer trips, they carried a few possessions with them. When trade began, they carried trade goods.

Then, at the beginning of the New Stone Age, animals were domesticated. Sometime later, pack trains of donkeys wound along the trail highways of southwestern Asia and Egypt. Caravans of loaded camels plodded along pathways east of the Caspian. Oxen and even sheep and dogs have had to carry loads in various parts of the earth.

As you read on page 184, the wheel was invented early in the Bronze Age. Probably animals had already been used for dragging loads over the ground. With wheels under the load, an animal could pull a much heavier weight. The first vehicle with wheels was undoubtedly a cart. The wheels were probably just round slices off a log, fastened to opposite ends of a pole. In the simplest form of cart, a box rests on the pole

Along Mexican roads farmers and handicraft workers carry their products to market on their own backs. This oldest method of transportation is still used in many lands that are not fully mechanized.

Fritz Henle





Alexanderson (CNS) from Guillumette

In various regions of the world where roads are very poor, you can see pack animals like these, carrying goods where no car or truck could travel. This is a road near Chengtu, China.

that connects the wheels. If two animals are to be used, a pole extends forward and is attached to a yoke that rests on the animals' necks. The pole is the means of pulling the cart, and it also helps to keep the cart from upsetting.

From these first primitive carts, two kinds of vehicles developed. When the box was made longer and two pairs of wheels were put under it, the cart became a wagon. Wagons were not much used until later, however. Most roads were too poor for the larger and heavier vehicles.

For travel rather than transportation of goods, the chariot was developed. It was almost always a two-wheeled vehicle like the cart. In time, chariots were made very beautiful, but the riders could not have

been comfortable, because they had to stand up while the light vehicle bounced over the rough roads or over no roads at all.

Ancient ships and water routes. There are no roads in the water, but there are regularly followed routes. We often speak of ocean routes as ocean highways. We also speak of rivers as water highways.

People began to use these water highways a very long time ago. Water travel probably began with floating tree trunks. A log will carry a man, especially if he is satisfied to float downstream. Hollow out a log and you have a dugout canoe. Almost everywhere primitive people knew how to make dugout canoes. Most of them also knew how to make rafts by fastening logs together.

Real boats built of planks are so old that we have no record of where or when they were first made. On page 184 you read about some of those ancient ships driven by oars and sails. In them traders made long voyages by sea. Water travel was very important in ancient times. The long rivers that could be used for transportation were one reason why ancient civilization developed fastest in the valleys of the Nile and Tigris-Euphrates rivers.

Roman roads. Road vehicles were improved in ancient times, but for a long while there was little improvement in the roads themselves. A road was a dirt track, and that was all. The first good roads came quite late in ancient times. They were built by the Romans. Probably you have read in your history books about the great Roman Empire. It was about the same size as the United States. When you think about ancient means of transportation, you realize that this was a very large area to be under one government. Officials and armies had to travel back and forth between Rome and the most distant provinces of the empire. To make their journeys faster and easier, the Romans built roads.

You might say that the Romans invented roads, for there had never before been anything like a Roman road. First, engineers surveyed the route. Then workmen dug a trench and filled it with crushed stone. The stone was leveled and pounded down until it was solid. Then flat stones were laid in a kind of cement to form the surface.

The Romans built thousands of miles of such roads. Over them traveled messengers on horseback, soldiers on foot, farmers with wagons and carts loaded with produce, herds of animals going to market, traders with wagons and pack trains. A few people even traveled over them for pleasure. For the first time in the world, travel was easy enough to be fun.

During the fifth century A.D., peoples from outside the empire broke in and con-

quered one province after another. The great Roman Empire broke up. Then came the long period we call the Middle Ages.

The culture of the early Middle Ages was much simpler and cruder than the culture of the Roman Empire, with little travel or trade. The people of the Middle Ages did not build roads. They did not even keep the Roman roads repaired, but they still used them. The old roads were the only ones they had. Centuries passed, and the roads became too poor for wagons. Carts were sometimes used on the best stretches, but most people who traveled at all traveled on horseback. The few trade goods that were carried by land were transported on the backs of donkeys, mules, and horses.

Better ships on old routes. The ships of the early Middle Ages were no better than ancient ships. At first they were not even as good. Nearly all techniques slipped

Ships like this were used to sail the Atlantic Ocean in the second half of the sixteenth century.



back a long way toward more primitive forms after the end of the Roman Empire. Sea trade never entirely died out on the Mediterranean. Ships from Constantinople (Istanbul) traveled over the eastern Mediterranean and met Arab ships from southwestern Asia and North Africa. Then a little later the Italians became the great sea traders of Europe, especially the people of Venice and Genoa. Arab and Italian ships still used both oars and sails. They still followed the old Mediterranean routes, too. Hundreds of years before, Roman, Greek, Phoenician, and Egyptian ships had been rowed or sailed over those same routes and had landed at many of the same ports.

Along the Atlantic coast of Europe in the early Middle Ages, Vikings from Scandinavia traveled in their long, swift ships. Usually the Vikings were raiders. Their ships had little influence on the development of shipbuilding in western Europe, except to slow it down. It was not until the Viking raids were over that other people of western Europe had much chance to go to sea.

When other western Europeans did have a chance, they began to build ships of a different type from those of the Mediterranean. Their ships were entirely too clumsy and tubby to be rowed. They had to depend on sails, even though they might have long delays waiting for a favorable wind.

PATHFINDERS TO A NEW WORLD

For thousands of years ships' captains had been finding their way with the help of landmarks. Phoenician traders crept along the coast all the way from the eastern end of the Mediterranean to Britain. Ancient Greeks and Romans and medieval Italians also followed the coasts as closely as possible.

Ships did cross the Mediterranean. In doing so, the crews had to be out of sight of land for a time. But if they got lost in the Mediterranean, they could easily find themselves again. North or south, they would soon come to land. By coasting a little way in sight of land, they could find a place they recognized.

A Science of Navigation

For thousands of years, people had been watching the stars. They knew that, wherever they were, one star could always be seen almost directly north, and that the other stars seemed to wheel around it each night. They knew that the sun rises north of east in the summer, and south of east in the winter; that it sets north of west in the summer, and south of west in the winter. They knew that the sun at noon is always to

the south, and that a noonday shadow always points north. None of these things are true south of the equator, but this was no problem for ancient and medieval captains. They did not know that the earth had an equator or a Southern Hemisphere.

Using their knowledge of the sun and stars, captains could tell directions in a general way. Unfortunately, in cloudy weather the sun and stars could not be seen. At best the calculations based on them were uncertain, for a captain had no way of measuring his exact position. He could not even tell the exact moment of noon, when the sun's shadow pointed directly north.

The Viking sailors of Scandinavian countries seem to have been a little more skillful at finding the way. They did sail westward on the Atlantic and discover Greenland, Iceland, and America. Each of these discoveries was made accidentally, however, by the crew of a ship blown off its course in a storm. Once these lands had been discovered, they could be reached again without too much difficulty. The distance from one landfall to the next in those far northern latitudes is not great. In sailor language, a landfall is a first sight of land.

Location on the earth. Europeans in early times were not the most skillful people in the world at finding their way about the oceans. The Polynesians were far more skillful. They are the people of the hundreds of small islands that dot the southern Pacific. Those islands are the most recently populated of any parts of the earth, but most of them had inhabitants at least a thousand years before Europeans knew anything about them. The people belong to a distinct group called Polynesians. According to their own traditions, their ancestors came from the mainland of southeastern Asia. Anthropologists think they are probably right.

While Europeans were getting lost in the Mediterranean, Polynesians were traveling all over the Pacific. They traveled in large dugout canoes. They had found most of the islands from Hawaii southward to New Zealand and eastward almost to the coast of South America. Several canoe-loads of explorers could find a new island, find their way back to their own small island, and describe the location of the new island so accurately that other people could find it in all the wide expanse of the Pacific.

The Polynesians were very skillful at telling directions by the sun and stars, and they made maps that were accurate and useful if you knew how to read them. The maps were made of sticks fastened together. They had no names on them, for the Polynesians had no method of writing.

On some of the islands there were schools for young men who wished to become navigators. A navigator is an expert trained to find his way over the ocean. Polynesian navigators learned to interpret the position and apparent movement of the stars and to read the curious stick maps.

You might remember 1400 as the date, in round numbers, when European navigation really began to improve. At about that time European navigators first had compasses. The compass is believed to have been invented in China. The essential part of a compass is a needle that is magnetic. From

ancient times people had known the magnetic qualities of lodestone, which is the same as magnetite, an ore of iron. They also knew iron could be made magnetic by rubbing it with lodestone. Someone found that a magnetic needle will point north and south if it is floated on a liquid so that it can turn freely. The floating needle was supported by a bit of very light material, such as pith from a plant. With compasses, European navigators had much more confidence. They were willing to venture out of sight of land for several days at a time.

Two other navigation instruments also came into use early in the fifteenth century. These were the cross-staff and astrolabe. Both of them were for finding north-and-south positions. What these instruments really did was measure the height above the horizon of the sun or a star.

With an astrolabe, a navigator could find his north-and-south position (latitude) quite accurately. For about three centuries more there was no equally accurate way of finding east-and-west position (longitude). As you have probably learned earlier, finding longitude depends upon knowing the difference in time. Navigators already had methods of finding the correct time where they were, but they had nothing to compare it with. If they could have kept the exact time of the port from which they sailed, they could have calculated the distance they had traveled east or west; but a small error in time means a large error in miles. Clocks and watches were not accurate enough then to keep time correctly during a long voyage.

With compasses and astrolabes, ship captains dared to risk getting out of sight of land. They invented a system for finding any port if they knew its location north and south. Here is how it worked.

Suppose you are a ship's captain with just those two instruments. You have come out of the Strait of Gibraltar, and you want to go to Southampton, England. You have to sail into the English Channel, and you know the latitude of the channel mouth. If you

had been a Phoenician captain, you would have had to follow the curve of the Bay of Biscay, but you are an up-to-date captain of the early fifteenth century. You have instruments, and you can take a short cut.

You follow the coast of Spain northward until you come to Cape Finisterre. Your map is not very good, but it is good enough to tell you that the English Channel is east of north, and so you tell the steersman to hold the ship to a course east of north.

Early navigators charting the course of a ship. One man is holding up a cross-staff, while the man seated is using an early type of globe.

The Bettmann Archive



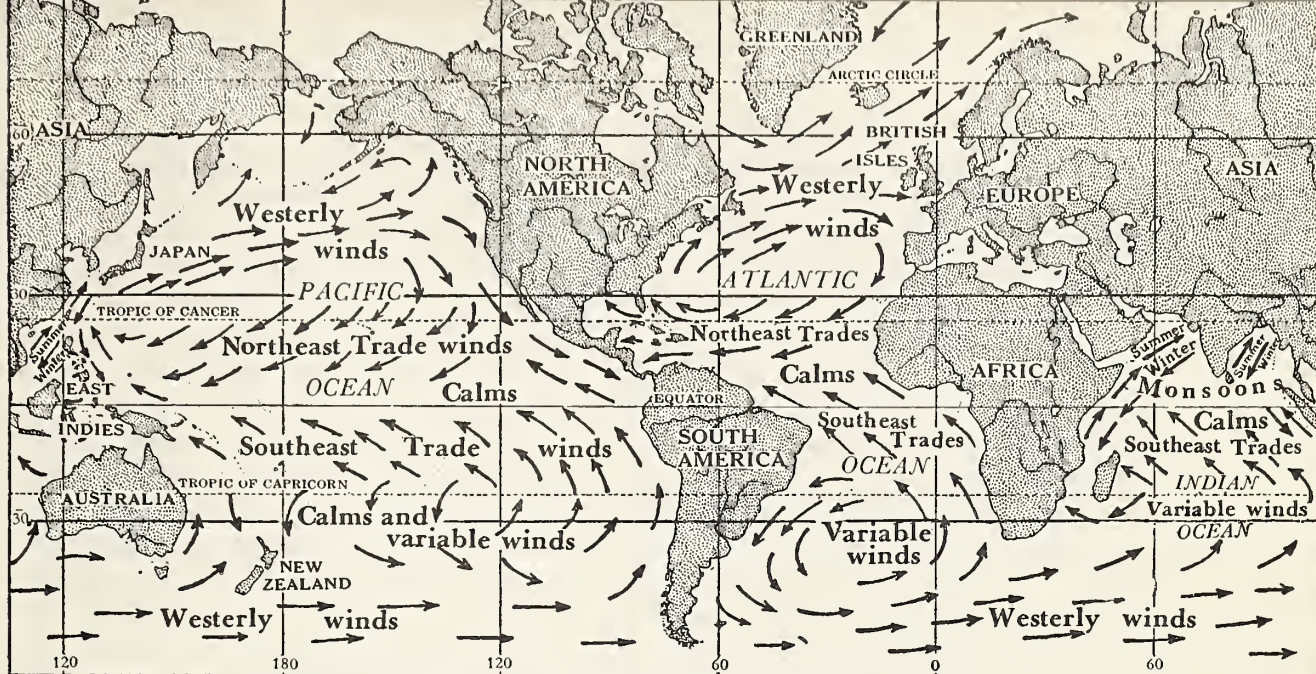
At frequent intervals you take readings from your astrolabe to find out how far north you are. At last you come to the latitude of the southern coast of Great Britain. There is no land in sight, but you know that land is due east, somewhere not far over the horizon. You need only sail east until you come to it.

Movements of water and winds. Of course the whole trip was not quite that simple. Off the coast of Spain there were several days of calm with no wind to push your ship. All you could do was wait.

Finally the wind came up again, and fortunately it was a south wind. Ships still had to sail with the wind. They could sail a little to the right or left of the direct force of the wind, but not much. Your ship did very well while the wind was from the south. Then it shifted to the southeast and carried you too far west, but you did get a west wind when you were in the latitude of the English Channel. You expected it, because in that latitude winds blew more often from the west than from any other direction. With the west wind you made good time to the harbor of Southampton. You got there while the tide was falling and consequently was running out of the harbor. You had to wait a few hours until the tide began to rise and rush into the harbor, carrying your ship with it.

You have probably read about the great period of exploration that started early in the fifteenth century, when Portuguese ship captains began exploring the western coast of Africa. Then, in 1492, almost at the end of the century, Columbus reached the West Indies. During the sixteenth century, Spanish, Portuguese, French, and English captains explored the coasts of the Americas, and settlements were begun. Before the end of the sixteenth century, Magellan and Drake had both sailed around the world.

Voyages were long and slow, but the captains gradually learned facts about the earth that made travel less difficult. They



The direction of the prevailing winds over the oceans.

learned that the winds did not blow in just any direction, by chance. The earth has a regular system of winds. In parts of the earth the wind almost always blows from a certain direction at a certain season. It may shift for a day or two, but it soon goes back again to the direction from which it usually blows—the direction of the prevailing winds. Look at the map at the top of the page to find the direction of the prevailing winds over the oceans. On land, differences in altitude as well as in temperature disturb this regular wind pattern.

To understand why the winds blow as they do, you need to remember some of the things you learned in your earlier years of geography. Do you remember how the warm air over the tropical region rises? As the air rises in the equatorial regions, air rushes toward the equator from the north and south.

If the earth stood still, winds from north and south would meet at the equator. But the motions of the earth cause the apparent path of the sun through the sky to swing north and south of the equator. Therefore we have seasons, and we also have a seasonal shift of wind belts. In the northern summer, the part of the earth under the direct

rays of the noonday sun is north of the equator. Therefore winds from the south blow across the equator.

The movement of the earth affects the winds in another way. You will probably need to use a globe to understand this. Ask someone to hold the globe for you. Place your finger lightly on the globe at the Tropic of Cancer. Shut your eyes and move your finger slowly toward the equator. Hold it so that you are barely touching the globe.

While you move your finger toward the equator, the student holding the globe rotates it toward the east, stopping the instant your finger reaches the equator. Open your eyes when you feel that the globe has stopped moving.

Your finger did not move straight south on the globe. It moved toward the southwest, because the globe was turning under your finger as you moved it. In other words, your finger was deflected toward the west.

Winds blowing southward toward the equator are deflected in the same way. Instead of blowing toward the south, they blow toward the southwest. Since we name winds for the direction from which they blow, they are northeast winds. Find the arrows that

stand for the northeast winds on the map. Then look for the arrow symbols for other prevailing winds.

South of the equator is a belt of winds that blow from the southeast. North and south of these belts of equatorial winds are the belts of prevailing westerlies. These winds are harder to understand than the equatorial winds, but they, too, are caused by differences in temperature combined with the rotation of the earth.

One true story will tell you the importance of the wind to early navigators. After the Spaniards had colonized Mexico, they wanted to start trade between the west coast of Mexico and the islands southeast of Asia. The authorities in Mexico sent a ship across the Pacific. It sailed westward and arrived safely in the islands, but it could not get back. Ship after ship made the long voyage toward the west, but not one could sail back eastward to Mexico again.

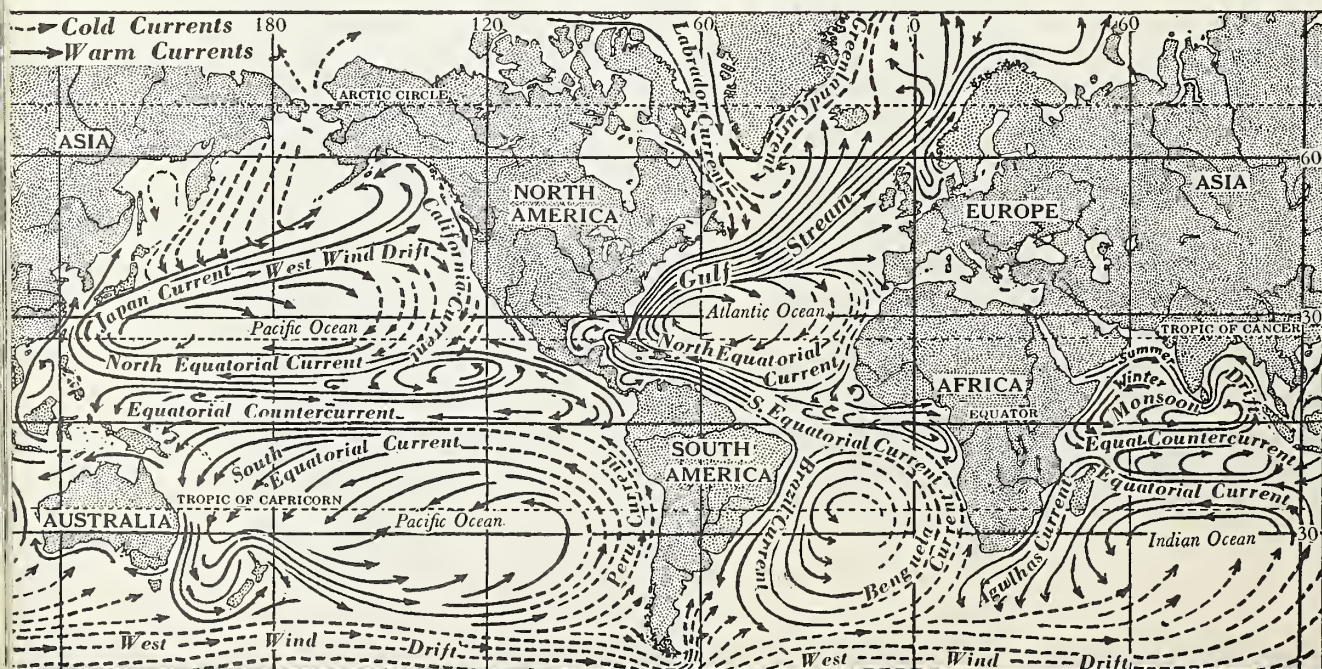
Years passed, and knowledge about winds increased. Finally a captain did get back. From the islands he worked his way northward along the coast of Asia until he came to the belt of prevailing westerly winds. Then he sailed eastward across the Pacific before those winds. His first landfall in America was in California. From there he

coasted southward to Mexico. For two hundred years a regular trade was carried on. Always the ships followed that same course—westward in the tropics, eastward in the middle latitudes. The captains went thousands of miles out of their way to get the benefit of the prevailing winds.

The map on this page shows ocean currents. *Ocean currents* are a regular flow of the surface waters of the ocean. The flow is caused by the prevailing winds blowing over the water. You can set up a current in a pan of water by blowing across the surface. Ocean currents are deflected by the rotation of the earth, as winds are, and also by striking against the continents.

Many of the currents shown on the map are slow and do not have enough force either to help or to hinder a ship very much. Others made a great deal of difference to early navigators. For example, in 1513 Ponce de Leon sailed from the West Indies to explore Florida. He sailed northward along the east coast of Florida and then turned back. His navigator wrote that the ship had a strong wind behind it on the return trip and seemed to be making good progress, but the sailors discovered that it was actually moving backward. They soon recognized that they were being carried along

The principal currents in the oceans of the world.



by a current stronger than the wind. They were in the Gulf Stream, which flows out of the Gulf of Mexico northward along the coast and then eastward across the Atlantic. You have probably learned how westerly winds blowing across the Gulf Stream warm the climate of northwestern Europe.

A few years later, Ponce de Leon's navigator was taking a ship from the West Indies to Spain, but he sailed far to the north before he turned east. It is believed that he had already traced the course of the Gulf Stream and was using it to help him get back to Spain. Other Spanish navigators knew it

soon and used it, but they tried to keep their knowledge a secret.

With the compass and astrolabe, with their knowledge of winds and currents, navigators considered themselves masters of the oceans. They could go anywhere on the ocean except to the icy polar regions, and they could come back again to their home ports. No doubt they were amused when they thought of those ignorant ancestors of theirs who had had to stay within sight of land. As a matter of fact, the series of inventions that were to lead to modern transportation had not even begun.

GREAT INVENTIONS IN TRAVEL

During the seventeenth and eighteenth centuries, great improvements were made in ships. The hulls of the ships were streamlined, so that they could slip through the water more easily. New ways of rigging, as well as changes in the hull, made it possible for ships to sail close to the wind. A captain no longer had to wait for a wind blowing just the way he wanted to go.

On land, too, methods of travel improved a little. Carriages were made for travel on

roads. The roads were still very bad, but there was a demand for better ones. A few were made with surfaces of crushed stone. Over them traveled stagecoaches and heavy covered wagons loaded with freight.

The Introduction of Power

Now look at your time chart of inventions. You will need to keep it in front of you as you read the next few pages. Almost as soon

A scene in early Idaho. Long after colonial days and until railroads were common, travelers to the Far West used stagecoaches. With a loaded coach and bad roads, horses could go only about five miles an hour.

Henry Fair Photo



as the steam engine was invented, a few people began to dream of using it for transportation. There was no hope of using it for transportation until Watt discovered how to turn up-and-down motion into rotary motion. Soon after he succeeded, other English inventors began to make small engines and mount them on carriages.

Before the end of the eighteenth century, there were primitive automobiles that really ran and carried passengers. Unfortunately, horses were frightened by the puffing, smoking things. The English parliament passed a law saying that automobiles might operate on the roads only if a man carrying a red flag walked in front of them so that people driving on the road might be warned in time. What was the use of inventing a vehicle that would not be permitted to travel faster than a man could walk? Horses could do better than that, and passengers would take stagecoaches. The English inventors gave up. At that time no other country had a high enough level of technology to make such an invention possible. Except for that law, steam-powered automobiles might have preceded both railway locomotives and steamboats. As it was, the steamboat came first.

Steam power for boats. Around the end of the eighteenth century, many people began to think that a steam engine could somehow be made to move a boat. A number of inventors went to work. In a way it was a harder problem than making an engine turn the wheels of a land vehicle. How to make an engine turn a wheel was already known.

The people of earlier times knew only two ways of driving a boat through the water—oars and sails. Sails were out of the question, but one inventor did succeed in making a steam engine drive the banks of oars in a boat. His name was John Fitch. His boat ran on the Delaware River at Philadelphia in 1786. It was a strange-looking craft, but it did run. It carried passengers for several years, but for some reason people were not much interested. Fitch finally gave up

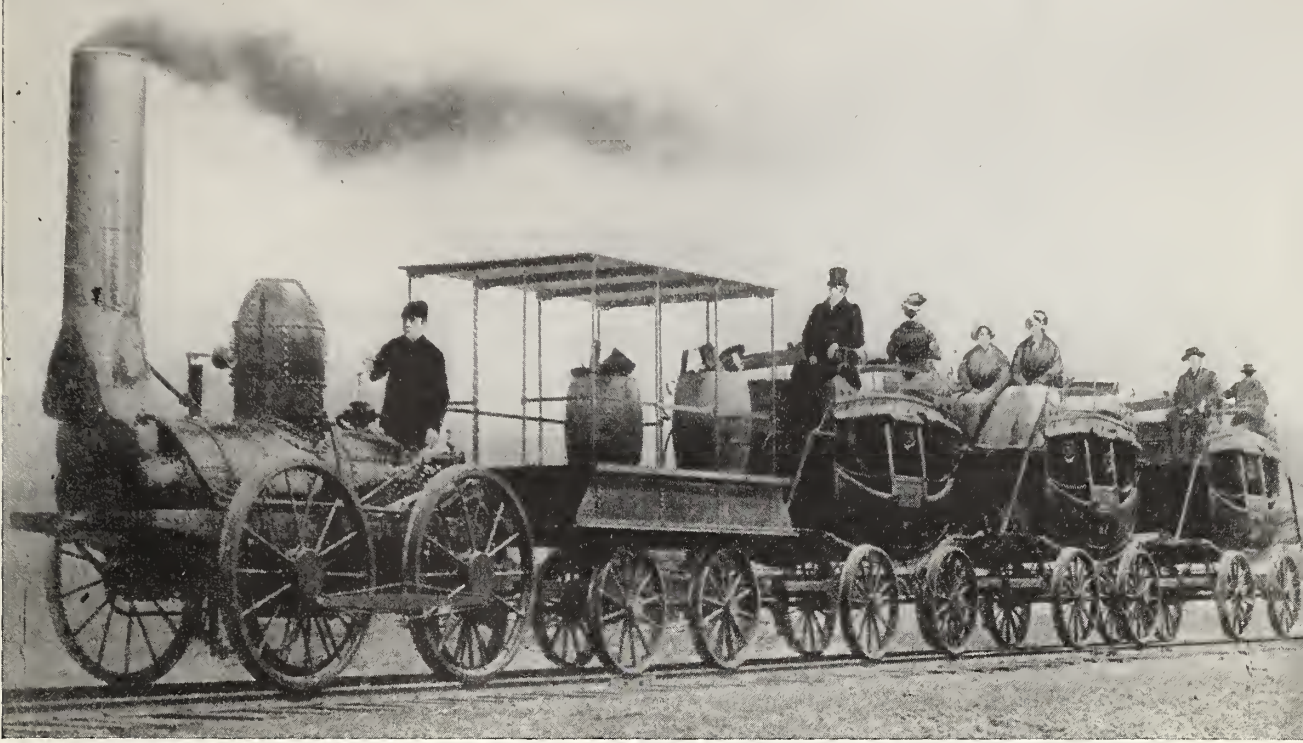
his attempts to start a company to manufacture and operate more of the boats.

Both in America and in Europe, other inventors were working on methods of propelling boats with steam engines. Several of them were able to make boats that actually ran and carried passengers. One of the inventors working on steamboats was Robert Fulton, an American. He had a boat built with great care and installed the best machinery he could get. For some reason he was able to arouse more interest than earlier inventors had been able to get.

Fulton's steamboat, the *Clermont*, made its trial trip on the Hudson in 1807. Many people watched its start from New York. All the way up the Hudson to Albany, people lined the banks of the river. The successful trip attracted attention all over the world. From that time to our own, many people have thought that Fulton invented the first steamboat. If they knew about the earlier experiments, they have called the *Clermont* the first successful steamboat. Some of the earlier ones were successful in the sense that they ran, but their inventors did not succeed in interesting people or in starting an industry.

The *Clermont* had paddle wheels to push it through the water. These were large wheels at the side of the vessel. They were not unlike some types of undershot water wheels, except that the paddle wheels were turned by power, and they pushed against the water as they turned. This was the usual method of propelling a steamboat for many years. Even the first ocean steamships had paddle wheels. Serew propellers had already been invented, but they were not very efficient until many improvements had been made. Then they took the place of paddle wheels on ocean steamships and on many river boats.

Railways and locomotives. You read about the invention of railway locomotives on page 189. During the 1820's, experiments and trial runs were made in England. The locomotives were successful. Soon they



Courtesy New York Central Lines

A locomotive of 1831, named for De Witt Clinton, the governor of New York. Its passenger cars look like stagecoaches. The engineer has no cab. Back of him are barrels of wood for firing the engine.

were being used instead of horses to pull coal ears. Before long there were a few short railway lines between towns, with cars to carry freight and passengers.

The first locomotive brought to America was never actually used. It was too heavy for the track that had been built for it. It did arouse much interest and proved to Americans that locomotives would run and could pull trains.

An American, Peter Cooper, built a lighter locomotive. It was bought to use on a railroad that had already been built for horse-drawn cars. Many people still believed that a steam engine on wheels could never run as fast as a horse, and so the owners of the railroad arranged a race. They had a few miles of double-tracked railway. The engine and the horse, each pulling a car, ran on the parallel tracks. The horse won, but only because a belt broke on the locomotive. Everyone could see that the locomotive was really faster.

The famous race between the locomotive and the gray horse was run in 1830. Within

a few years a number of short railway lines were built, but people still did not think of railways as a means of long-distance travel and transportation. The Erie Canal had been opened in 1825 and was proving very successful. For many years, Americans took more interest in canals than railroads.

Steam and population. Steamboats and locomotives were invented when most of North America was still unsettled. They had a very great influence on the course that settlement followed during the next half century. On page 228 you read how Eli Whitney's invention of the cotton gin speeded up the of settlement the South. Without the steamboat even the cotton gin would not have made cotton farming possible in most of the South. Cotton is a heavy and bulky product. There would have been no use to grow it if it could not have been taken to market.

The first steamboat to go down the Ohio and Mississippi rivers from Pittsburgh reached New Orleans in 1812. What is



Steamboats on the Mississippi, at Cairo, Illinois. There are few seen now, for railroads, often built along the river's edge, robbed the boats of their importance and caused the decline of river traffic.

more important, it went back up the river. It had always been possible to float heavy loads downstream, but never before had there been a satisfactory means of carrying cargo upstream. Before many years had passed, there were hundreds of steamboats on the Mississippi and its tributaries.

Railroads spread more slowly. If you turn to the map for 1840 on page 376, you will see that there was still not much railway mileage in North America. The only roads more than a few miles long were in the East, in the region already most densely populated. During the next decade, the 1840's, more railroads were built, but they were still used chiefly as a means of connecting waterways. The frontier of settlement was still far beyond the railways.

In the 1850's, Americans really got to work laying tracks. Short lines were connected. Long lines stretched out across sparsely populated areas. During this decade, it was possible for the first time to travel by rail all the way from the Atlantic coast to the center of the continent.

As railroads were built into the grasslands west of the Mississippi, they opened up new areas for settlement. Some of the land was too dry for the kind of general farming that had been done in the forest regions, but it was fine for wheat. Like

cotton, wheat must go to market. Settlers could not move into the wheat country to make a living by farming until they had transportation for their grain. On page 99 you read how cattle ranching began in the drier area of the Great Plains. Ranching would not have paid if there had been no railroads to carry the cattle to market.

In 1869 the first railway to the Pacific coast was finished. You can find it on the map for 1870, page 377. Compare this map with the one on pages 374-375. The railway network of the present had already taken shape by 1870. By 1890, as you can see in the next map, nearly all the present main lines had been built.

Modern Transportation

You have seen how power was first used in transportation and how it was first applied to land and water travel. A number of new methods of transportation have been invented since, and a great many improvements have been made in the old ones.

Ships at sea. In both America and Europe the first steamboats were river boats. Inland transportation was more urgently in need of improvement in those days than ocean transportation. The inventors were

trying to solve the problem of how to transport goods upstream on rivers, and steamboats solved the problem.

After steamboats were built, however, it was not long before they began to put to sea. They began first with short coastwise trips, but in 1818 the *Savannah* crossed the Atlantic from Savannah to Ireland with the help of engines. The *Savannah* was really a sailing ship with engines and paddle wheels to be used when the wind failed. Ships that depended entirely on steam did not come until several years later.

On pages 191, 192, and 193 you read about some of the more recent developments in engines for ships. Far larger and more comfortable ships have been built, too, but the essential features of modern ocean vessels were present before 1890.

Wheels on rails. The locomotive in the picture on page 283 was built in 1831. The pictures on this page show how steam locomotives have changed in appearance from that time to the present. For a long time they looked very much like the one at the top of this page, which was built in 1851. The fuel was wood, and the flaring smokestack was supposed to trap the flying sparks and prevent fires along the tracks.

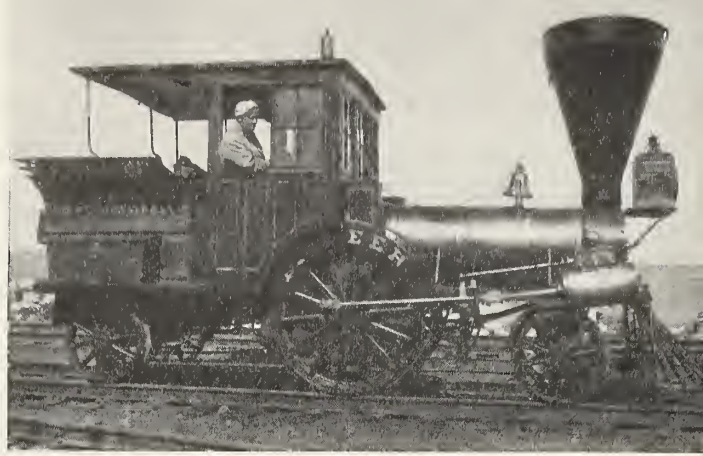


Foto-News

Twenty years after the "De Witt Clinton." The engineer now has a cab. What else has been added?

Modern locomotives not only look different but also are far more efficient. The change from wood to coal as fuel was one of the first steps toward more powerful engines. Turn back to pages 189, 191, 192, and 193, and read again about improvements in the use of power on the railroads.

There has been equally great improvement in arrangements for the comfort of passengers. The first passenger cars were stagecoaches fitted with wheels designed to run on rails. For many years the cars still looked like stagecoaches stretched out longer and longer. Passengers did not expect to be comfortable on a long railway trip. Magazines were full of jokes that concerned

A powerful locomotive of the twentieth century, the "Big Boy" of the Union Pacific Railroad, used to draw heavy loads over mountain grades. Compare it with the "De Witt Clinton" on page 283.

Ewing Galloway



the discomforts and inconveniences of the railway travel of their time.

Early railway travel was dangerous as well as uncomfortable. The invention of telegraphy in the 1840's brought about a great improvement in railway safety. With telegraph instruments in every station, train dispatchers always knew the location of all trains. Then signaling devices were invented and installed so that engineers could always know when they had a clear track. Now devices are coming into use that will stop a train automatically if there is danger ahead.

Nothing did more to make railroad travel safe than air brakes, invented in 1868. They work by means of compressed air, and with them the engineer can set the brakes on every car in the train. Before they were in use, an engineer who saw danger ahead could only put his engine in reverse and toot a signal on his whistle. Then a brakeman on each car scrambled for a wheel that looked much like the steering wheel of an automobile and began to turn it with all his might. The wheel set the brakes on that one car. Seldom could brakemen work fast enough to keep the train out of trouble.

Even with our newer methods of transportation, we could not live comfortably for a day without our railroads. Perhaps we think most often about passenger trains, but freight trains are far more important. They carry most of our heavy and bulky goods, such as coal and steel. They also carry most of our perishable foods that must travel long distances. In fact, nearly every article we use has depended upon railway haulage at some stage between the source of the raw material and the store in which we bought it.

Wheels on the road. After the early success of the railroads, there was little interest in road vehicles for a good many years. Toward the latter part of the nineteenth century, inventors became interested again in better means of highway travel. In the meantime, many other inventions had pre-

pared the way for a far better road vehicle than could have been produced in the early years of the century.

Turn back to pages 191-192 and review what you learned there about the invention of the internal-combustion engine and the first automobiles. Bicycles made several contributions. The modern type of bicycle was invented in the 1880's. In early automobiles, chains like bicycle chains were used to turn the wheels. Rubber tires blown up with air were invented for bicycles by an Irishman.

No complex invention has ever been made entirely by one person. It is always the result of the work of many people. Finally someone puts together the earlier ideas and inventions and makes something new. Hundreds of people contributed to the automobile. Back of the automobile were whole series of inventions, of which only a few have been mentioned here. Usually we credit an invention to the person who finally puts the parts together and makes them work. We cannot even do that in the case of the automobile. If any one person could be called the inventor of the modern automobile, it is probably Karl Benz, a German. In 1885 he built an automobile with a gasoline engine. It ran, and it attracted much attention, but Benz did not then make automobiles to sell. Charles Duryea, an American, started the automobile on its way as a real means of transportation in 1892. In 1908 Henry Ford, another American, began to build automobiles at a price that a great many people could afford to pay.

The first internal-combustion engines were not powerful enough for heavy vehicles. Trucks and busses were not widely used until the 1920's. When automobiles, trucks, and busses had been improved enough for long-distance transportation, another difficulty still stood in the way. Outside the cities there were few good roads. Then a period of highway building began that might be compared with railroad building in the 1850's. Between 1920 and 1940 the densely

populated regions of North America and Europe were covered with a network of paved highways.

Good vehicles on good roads gave people more freedom of movement than they had ever had before. They began to travel more and get acquainted with other regions. Farmers could get to stores more easily and no longer needed to depend upon themselves for so many things. City people had a chance to see the country. People could live farther from their work, and cities began to spread out. Farmers could take their products to market more easily, and they could take them farther. But the story of how improvements in transportation affected the marketing of products belongs in the next chapter.

In the air. "I could no more do that than I could fly." A great many people can remember when those words were the common way of saying that something was absolutely impossible. People had been going up in balloons for more than a hundred years, but going up in a balloon is not flying.

As far back as the late Middle Ages a few people had believed that it might be possible to make a machine that would fly. Strangely, the more scientists learned about the world, the more impossible flying seemed. Earlier ideas about flying were proved wrong, and anyone who thought of flight was considered an impractical dreamer. The doubters were correct, for their own time. Flight was impossible before the invention of a lightweight, powerful engine that could use a lightweight fuel.

In 1896 Samuel P. Langley almost became the inventor of the airplane. He made a model, with a small steam engine for power. It actually flew for three-quarters of a mile. Later he made a larger one, designed to carry a man, but it would not fly. If he



Ewing Galloway

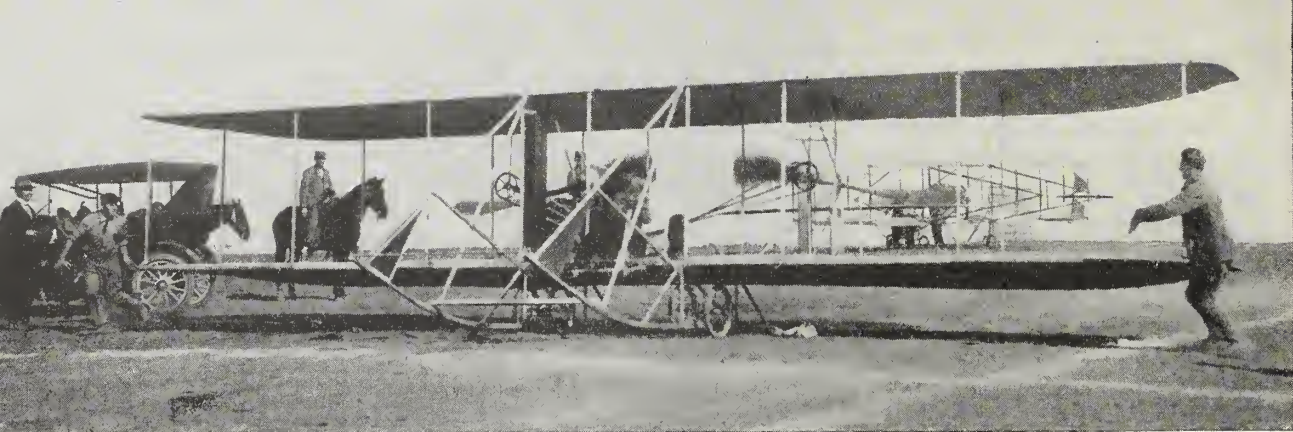
A Ford of about 1905. By means of standardized parts and assembly lines, Ford was able to make the first cheap cars.

had tried longer, he undoubtedly would have succeeded, but he was out of money and discouraged. He gave up too soon.

In the year that Langley's model plane made its first flight, two young men in Dayton, Ohio, began to play with the idea of building an airplane. They were the Wright brothers, Wilbur and Orville, proprietors of a bicycle repair shop. For several years they experimented with gliders, to learn about the lifting power of the air. Then they built a plane with an engine.

In 1903 they were ready to try their plane. Orville, in the pilot's seat, started the engine. The propeller turned and the plane started down the runway into a strong wind. After running for forty feet, it rose a few feet from the ground and flew for twelve seconds. Those twelve seconds marked one of the great turning points in history. The two young bicycle repairmen will be famous as long as records of human progress are kept.

However important that first flight may have been, the air age did not begin in 1903. For the next ten years, airplanes were merely curiosities, but they were much improved. World War I came in the next



Margaret Romer

The way an airplane looked back in 1911. There was no fuselage. The pilot sat in the open air. Wings were made of fabric stretched over a light wooden frame and were braced with strips of wood.

decade, and planes were used. By the end of the war, they had been greatly improved, many young men had learned to fly them, and for the first time people really believed that they could be used for transportation.

During the 1920's commercial air lines began carrying passengers on regular schedules.

Air-mail service was started. Metal planes were built and began to have their present outline. Earlier planes had been made of cloth stretched over a light wooden framework, and nearly all were biplanes. On page 193 you read about some of the more recent developments in planes and engines.

THE SPREAD OF IDEAS

This section is about communication. In the simplest terms, *communication* means telling somebody something. You carried on communication with your family at the breakfast table this morning. You did not call it that. No one would. Ordinarily people keep their big and formal words for larger and more general ideas. At the breakfast table you and your family just talked.

Messages and Messengers

It is a general belief that primitive peoples had simple languages. We sometimes think of early man as communicating by gestures and grunts. There is no evidence for this whatever. The most primitive languages we know about are very complex. The grammar is much harder to learn than the grammar of the English language. It is much harder than the grammar of Spanish or French or Latin or any other language that people ordinarily learn in school.

People who grow up speaking these complex languages usually speak them correctly. They learn the difficult speech without any language textbooks. It is generally true that peoples with the most complex languages are those with no method of writing.

The invention of writing. Various peoples developed a fairly complex culture without writing, but they had to have very well-trained memories. Without writing, every technique and all records of past events must be learned and remembered.

All but the most primitive peoples are interested in their own past. They want to know how they came to be where they are and to have the culture they do have. For example, the Polynesians on the Pacific islands were much interested in their ancestors. Many of them could recite lists of ancestors, going back for hundreds of years. There is good reason to think their lists were correct, for there are instances in which a

group of people migrated from one island to another far away and had no later contact. In each group, people remembered the lists of ancestors, and their lists agreed for the ancestors before the migration. The Polynesians also had traditions about their migrations that have proved to be mainly correct.

The Aztecs of Mexico were the only American Indians who had any system of writing when the European explorers came. The great Inca Empire in South America was run without any way of keeping written records; but the people did have a way of reminding themselves of what they wanted to remember. They tied knots in strings. The number of the knots and the color of the string had special meanings. When the emperor wished to send a message, a runner carried it on foot. He had to learn the message by heart, but he was given a handful of knotted strings as reminders. If the Indians had thought of using marks on a piece of bark instead of knots in strings, they would have had the beginning of a method of writing.

Some of the more primitive Indians of North America came nearer real writing. They drew pictures as reminders and messages. Some of their pictures represented the actual objects, and some had symbolic meaning. For example, a picture of the sun stood for a day. The writing of the Aztecs had been developed from such pictures.

Probably all writing began as picture writing. You know how Egyptian hieroglyphic writing looked. It was made up of rows of small pictures. The pictures were symbols. They stood for syllables of words, not for the object represented. During all their later history, the Egyptians had a simpler kind of writing which they used in their everyday business; but they still used the pictures for more formal records, such as inscriptions on buildings. The symbols in their ordinary writing were much simplified forms of the pictures.

Even our own alphabet began as picture writing. The letters can be traced back to

simplified pictures. Probably the pictures first stood for the real object, then for words. The symbols became an alphabet when someone thought of letting them stand for sounds. When symbols stand for words or ideas, the student of reading and writing needs to learn thousands of them. We need learn only twenty-six in order to write any word in our language.

Communication by writing. Not everyone knew how to read and write in ancient times, but a great many people did. We usually think of the historical records left from ancient times, but people wrote all sorts of everyday things, too. Businessmen kept accounts. Contracts and deeds to land were written and signed. From the Tigris-Euphrates Valley we even have such ordinary things as laundry lists, written on clay. We also have clay tablets on which school children practiced writing. People wrote letters, too, although there was no regular post-office system. Important letters, such as government messages, were sent by special messengers who usually rode horseback. Other letters were sent with travelers who happened to be going in the right direction.

Many ancient kings set up inscriptions telling about their own glories and conquests. Almost four thousand years ago a king of Babylonia, in the valley of the Euphrates, had a new idea. He collected all the laws of the kingdom and had them carved on stone pillars set up in various places. That was perhaps the first attempt to make useful information available to everyone.

Early writing usually had a practical purpose. The Greeks were the first people who did much writing just because they had ideas they wished to express. They are also the first people who did much reading for pleasure. Most Greek men and a few women could read and write. In ancient Rome both boys and girls were usually taught reading and writing.

We might say that the Romans invented newspapers. Every day the government



CNS from Paul Guillumette

Like the ancient Romans, some Chinese people today get their news by reading newspapers posted in the public square.

officials posted important news items in the forum (public square). People had to go to the forum to read the news. Then someone thought of a new business. He found people who wanted to know the news but did not want to go to the forum to read it. He copied it each day and sent copies to their homes. Other copyists soon followed his example, so that any Roman who paid for it could have the news delivered to him.

Everybody Reads

The Roman Empire was broken up, as you know. Roman culture largely disappeared, and with it disappeared the common knowledge of reading and writing. During the

early Middle Ages, few people except priests could read or write. They still wrote in Latin. The present languages of Europe were just developing, and were not considered dignified enough to be written. Until late in the Middle Ages, anyone who wanted to learn to read had to learn Latin first.

As you read earlier, there was little trade or business for several hundred years. Then, when trade grew up again, traders needed to keep records and write letters. They saw no reason to learn Latin, and so began writing in their own languages. A few people began to write books in their own languages, too. Perhaps you have heard of Geoffrey Chaucer, who died in 1400. He was the first important author to write in English.

By the fifteenth century, a good many people could read, but they still had little to read. Books had to be copied by hand and were very expensive. A few people were getting more modern ideas about the world,

but there was no easy way for those ideas to spread to all the people.

The printing press. In the middle of the fifteenth century came another of the world's great basic inventions—the printing press. Type was invented in China. First the characters for a page were cut in a block of wood. Later, separate blocks were cut for each character. These blocks could be set up for the printing of one page and then separated and set up again for another page, just as you can make many different words with a child's blocks. This idea of movable type, with one character on each piece of type, was necessary to make possible the printing of real books.

Two other inventions were necessary before printing could be easy and cheap. One was the printing press, to squeeze a sheet of paper against a whole page of type at once. Actually, two pages were printed at once on the early presses. Now, for books, sixteen or thirty-two are usually printed at the same time on one side of a large sheet of paper. The same number are later printed on the other side of the sheet.

The second necessary invention was metal type. The type designer still cut the letters on tiny blocks of wood, but he did not use the blocks for printing. He used them as patterns for casting metal type.

As you know, paper had already been introduced in Europe. It, too, was necessary for printed books. By 1500 there were many printing presses in Europe. Printing came just in time to spread the new knowledge about the world gained during the period of exploration.

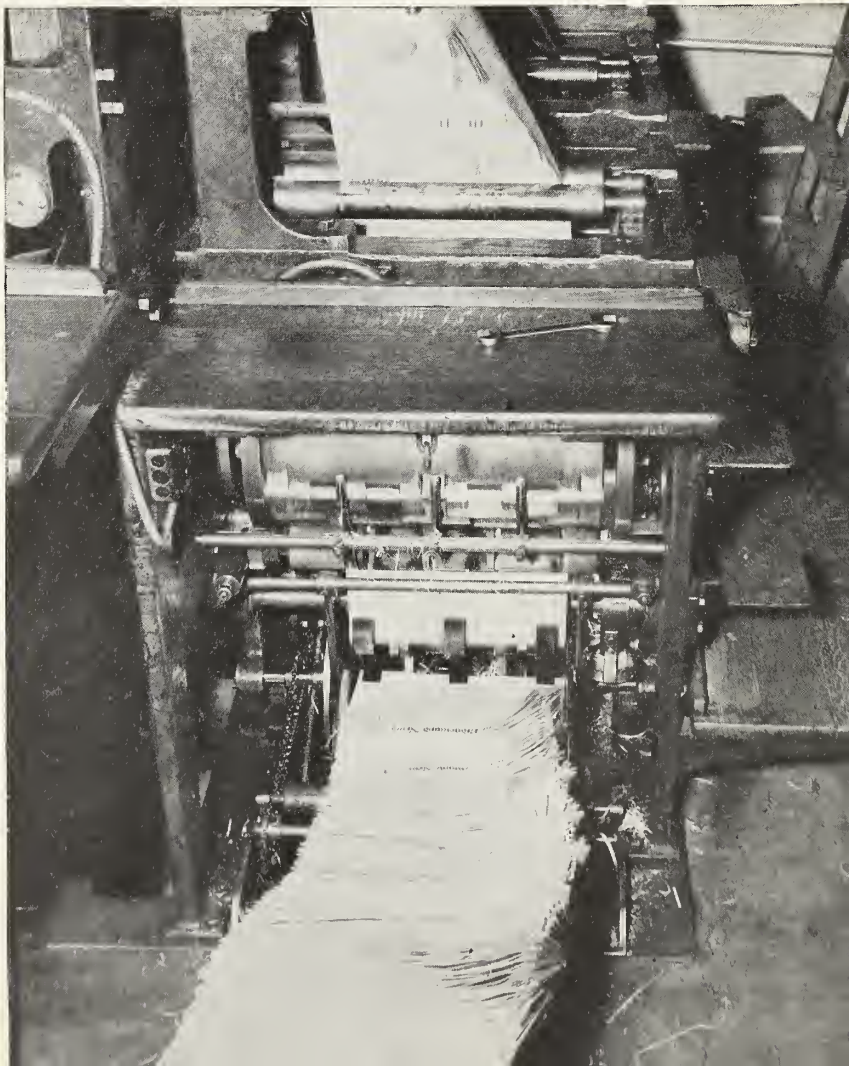
When books became abundant and fairly cheap, more people learned to read. By the time settlers began coming to English-speaking North America, the people of western Europe already believed that every child should be taught to read and write. Americans have always believed this. With the knowledge of reading, anyone can learn all he wants to know on any subject. Without it, he is lost and helpless in our modern world of books. Now most of the countries of the earth have laws requiring that every child go to school at least long enough to learn reading and writing. Even in African villages there are schools. There are schools for Eskimo children in the Arctic regions. On every continent millions of children are learning the meaning of printed symbols in

primers and readers. As they grow older, they make use of their reading skill to get useful knowledge about their world, just as you are doing now.

Current events. Writing and publishing a book is quite an undertaking, even to-day. It takes time. You would not expect to learn from a book what happened last week or even last month. During the 1600's people began to want more up-to-date information than they could get in books. Publishers soon began trying to give them news about current events. They printed interesting news items on single sheets of paper. Thus newspapers began. At first they were not daily papers. They were

Newspapers fresh from the press. Unlike most books, papers are printed on long strips of paper that unwind from rolls. The machine in the picture cuts apart the sheets and folds them.

Philip Gendreau



published once a week, or perhaps not at any regular interval at all.

During the eighteenth century newspapers became common. Before the end of the century, at least one was published regularly in nearly every city of America and western Europe. Most of them were still weeklies, but there were a few daily papers. A few magazines were published, too, with articles on topics of interest. There were no story magazines. People still read for information rather than amusement.

In the early newspapers, only home-town news was really up to date. News could travel no faster than a horse or a sailing ship. When a ship from Europe came into the port of New York or Quebec or Philadelphia, people were more eager for the news

it brought than they were for the goods in the hold. By the time European news reached America, it was usually several months old; but it was the nearest Americans could come to world current events. Even the news from another American colony might be several weeks on the way.

Carrying the mail. Do you happen to be a stamp collector? Probably some of you are, and you may have stamps from every country in the world. If you know the name and address of anyone anywhere, you can write him a letter and he will almost certainly get it. We are so used to having letters and magazines brought to us every day that it is hard to imagine a time without regular mail service. In fact, the idea

of regular mail service began at about the same time as the publication of the first newspapers.

In earlier times a letter had to be sent by messenger or by any willing traveler. For a fee a ship's captain would usually consent to take a letter with him. Stagecoach lines also carried mail. The first regular mail route in America ran between New York and Boston. Letters and newspapers were carried by men on horseback called postriders. The rough and muddy trail they followed is now a paved highway, still called the Boston Post Road.

During the eighteenth century, national governments began to take over the job of managing the mail service. Post-office departments arranged to send mail all over their countries as quickly as possible, but it was still carried by ship, stagecoach, and men on horseback.

When steamboats and railroads appeared, the mail traveled faster. News, in the form of

A railway mail car. Mail is picked up at stations and sorted on the way. It is unloaded at the proper cities and towns for delivery or for transfer to another railroad.

Brown Brothers



letters and newspapers, traveled by the fastest means of transportation available, but still no faster than wheels and ships could carry it. People began to think that this was not fast enough.

Faster than Wheels

Even primitive peoples have tried to find a way of sending messages faster than a person can travel. Probably you have heard about Indian smoke signals. An Indian who wished to send a message built a smoky fire. By covering and uncovering the fire, he allowed the smoke to escape in puffs. The puffs of smoke could be arranged according to a code. They did not spell out words, of course.

Fires have been used for signaling in other parts of the world, too. In Europe, fires were built by watchers along a coast to signal that a ship had been sighted. Fires on hilltops called men to arms when an enemy was on the way.

From ancient times mirrors were used for signaling. Undoubtedly you know that sunlight is reflected from a mirror as a dazzling flash. It is not difficult to arrange the flashes in a code of signals. Any of you who are scouts know about wig-wagging, too. It is a method of signaling by the position of the arms. The signaler usually holds colored flags that can be seen easily.

All these methods of sending messages depend upon sight. A column of smoke, the position of a man's arms, or even a mirror flash or a fire on a hill at night cannot be seen very far. They could never have been used to spread news over the earth.

Other methods of sending messages depend upon hearing rather than sight. For example, the natives of the tropical forest regions of Africa use drums for sending messages. Villages are only a few miles apart. Each village has its drummer, who is expert in the use of the great booming drums that send out the messages. The drumbeats can be heard for miles. In each village where

the message is heard, a drummer sends it on. By means of the "talking drums," news is quickly spread over a large region.

No American or European has ever been able to send or understand the African drumbeat messages. There seems to be no regular code of signals. The drummers themselves say they make the drums talk. They insist that they make the sound of words with the drumbeats. Even to a European who knows the language of the tribe, the drumbeats do not sound like words. Perhaps there is a special language for drums. Though we do not know just how, the Africans understand the messages. Long before a traveler reaches a village, the villagers know he is coming. They also know how he looks, how many people are with him, what equipment he has, and why he is making the journey.

Wouldn't it be funny if we had to get our news from drummers stationed every few miles to relay a message? We do use sound for some kinds of messages. Railroad engineers, for example, use codes of whistle signals. But we have ways of sending messages that are faster than sound and ways of carrying our words to places far beyond the range of our eyesight.

Telegraph messages. On page 194 you read about the invention of the telegraph instrument. Samuel F. B. Morse is credited with the invention but, as usual, the invention would not have been possible without the work of other people. Your time chart should tell you that a long succession of scientists had been working with electricity for many years. Their discoveries made the telegraph possible. Morse was not even the first person to think of using electricity to carry messages. Other inventors were working on the same problem at the same time. An entirely different method was invented in England and was used there for a while. Morse's instrument proved more satisfactory, however, principally because it was simpler to use.

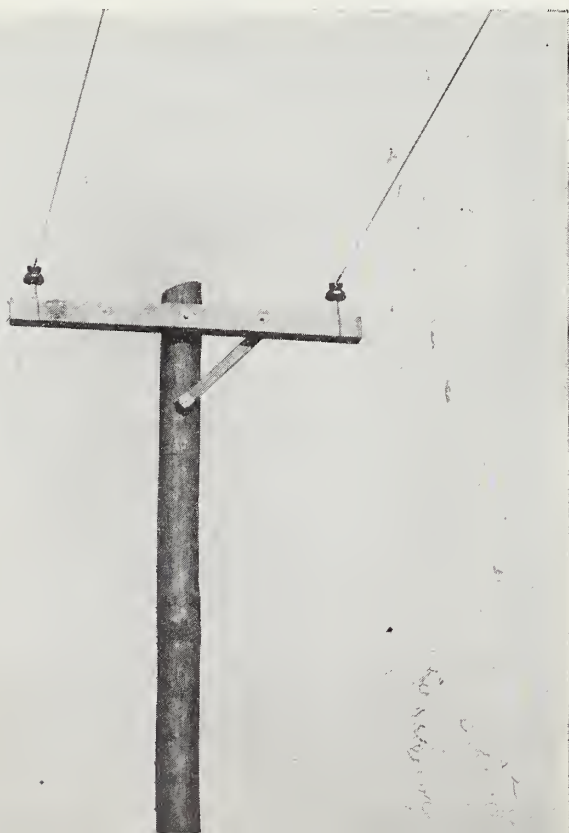
The first message over any considerable distance was sent between Washington and Baltimore in 1844. At first most people doubted the usefulness of telegraphy. But before many years had passed, it was looked upon as a necessity wherever in the world quick communication was important. In 1851 it was first used by a railroad for dispatching trains.

A current of electricity takes time to travel. If you had a wire strung all the way around the earth and back to you again, you could prove it. If you clicked a telegraph instrument to send a signal over the wire, you would hear the returning signal as if it were an echo of the one you sent. The interval between the clicks would be less than what most people call "no time at all."

An electric current takes time to travel, but its speed is so great that its journey to any point on the earth is practically instantaneous. As soon as wires could be strung, communities could get news of an

A simple telegraph pole with one crossarm and two insulators to support wires. Most poles have several crossarms and many wires.

Kaufmann & Fabry Co.



event within a few minutes after it had happened. Newspapers began to include sections of telegraph news. Businessmen learned at once of events that affected their business. Wherever in the world telegraph lines reached, ways of living and thinking were changed.

World communication. The problem of getting news across the ocean was not yet solved. You could not string wires across the ocean. Or could you? Some people began to think it might be possible. Within ten years after Morse sent his first message, there were short underwater cables. The two longest ran from Scotland to Ireland and from England to the Netherlands. Then an American, Cyrus W. Field, began to think about a cable across the Atlantic.

After careful study, Field decided that a cable could be laid from Newfoundland to Ireland. If you study a globe, you can see why he chose those two places for the ends of the cable. Even there, however, the distance across the Atlantic is 1950 miles. Along most of the way the water is comparatively shallow, but there are places in which it is more than two miles deep.

Field had money, but not enough for such a large project as this. Most people considered it a wild dream, but Field must have been very persuasive. He got some of his friends to go into it with him and then got the governments of Great Britain and the United States to help. Each sent a ship. Loaded with many miles of cable, the two ships met in the middle of the Atlantic. They spliced together the cable ends, and then each worked back toward its own continent. By August, 1858, the cable was being used for messages. It worked for just three weeks. No one yet knows what went wrong. The wires may not have been properly insulated against the chemical action of salt water.

Field started at once trying to raise money for a new cable, but he had a harder time than before. Then when he did get the

work started, the cable broke several times during the attempts to lay it. In 1866, however, Europe and America were successfully linked together by copper wires. Communication has not been broken since. Other cables were soon laid from continent to continent and from the continents to many islands.

Cables still break sometimes. Now there are devices on shore that tell the cable tenders where the break has occurred. They send out a ship to make repairs. The information they have is so accurate that the repair crew can drop grappling apparatus down through two or more miles of water and fish up the broken cable ends. Then the cable ends are spliced together.

With cables to tie the continents together, people no longer had to wait for news. Newspapers began to report events from every continent on the day they happened. Knowledge is very important to citizens of a democracy. They cannot vote intelligently unless they understand the issues. A great many people have worked hard to make it possible for us to get information on world affairs. It is our responsibility to read the news, to learn to understand it, and to form sound judgments based on what we have read.

The telephone. You read about the invention of the telephone on page 194. Do you have the date, 1875, on your time chart? The basic idea back of the telephone is quite simple, but working out the details was not so easy.

Sound travels through the air in tiny waves, or vibrations. The particles of gas that make up the air actually move. When



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There must be something wrong with this cable. The pronged grappling hook, fastened to a chain, was lowered to the bottom of the ocean to bring it up.

you speak into a telephone, the air waves set up by your voice strike a thin disk of metal in the mouthpiece called a diaphragm. The diaphragm vibrates just as the air does. Back of the diaphragm is a space filled loosely with tiny particles of carbon. As the air waves set up by your voice push the diaphragm in, it presses the carbon particles together so that more of them are in contact. An electric current passes over the wire. More or less current can pass through the carbon according to the degree

of tightness with which the particles are pressed together by the vibrations of the diaphragm in the mouthpiece.

At the receiving end, the current passes through a coil of wire that acts as a magnet. The magnet is just behind a diaphragm in the receiver. As the current varies, the strength of the magnet varies. The variations in the current cause the diaphragm to vibrate. The vibrating diaphragm sets up sound waves in the air exactly like the ones that struck the diaphragm in the transmitter. No sound passes over the wire—just an electric current that varies according to the vibrations. The receiver turns the current back into sound.

For a number of years the telephone was useful only for communication within one city. Then wires were stretched from city to city, and long-distance service became possible. At first the distance was not very long. The electric current that passes through your telephone instrument is weak. It would not do to use a very strong current. On the other hand, a weak current does not travel very far. To make telephone conversation possible over really long distances, booster stations along the way are necessary to amplify the current.

Seventeen years after the telephone was invented, it was possible to telephone from New York to Chicago. Twenty-three years more were needed before conversations could be carried on all the way across the continent from New York to San Francisco. It has never been possible for wires to carry a telephone conversation across the ocean from continent to continent; but it is possible for you to pick up your telephone at home and call up practically anyone in the world who has a telephone. How it is done is part of another story.

Messages without wires. In the latter part of the nineteenth century, scientists discovered new forms of energy and ways to control them. All these forms of energy travel in waves. Light and heat are both

forms of energy that travel in this way. The newly discovered ones are some that we cannot see or feel. We must have the right instruments to detect them.

One group of these energy waves we now call radio waves. Almost at the end of the nineteenth century (1896), an Italian scientist, Guglielmo Marconi, found a way to use radio waves to carry messages. He invented instruments to turn electricity into radio waves and send the waves out to be picked up by other instruments. The new method of sending messages was called wireless telegraphy, or just wireless.

You would be amused if you could read what people said about wireless at the time it was invented. At first they thought it would not work. Then they thought it would not be useful if it did work, because anyone with a receiving set could pick up the messages. They must have thought that people wanted to send only secret messages.

Marconi's invention did work, and people did not seem to mind its lack of secrecy. One of its first important uses was on ships at sea. Until wireless was invented, ships were completely out of touch with the land and with other ships. Wireless gave them a means of communication, and it has saved a great many lives at sea. The code letters SOS were agreed upon as a call for help. They became so familiar that they are now part of our everyday speech.

Perhaps you have heard the story of the sinking of the great steamship *Titanic* on its first voyage in 1912. The *Titanic* wireless operator sent out an SOS after the ship struck an iceberg. From hundreds of miles away, ships began steaming at full speed toward the sinking *Titanic*. Because of wireless, hundreds of lives were saved. Unfortunately, the two ships nearest did not get the message. One had no wireless; on the other, the only wireless operator was off duty. If those two ships had got the message, everyone might have been saved. Although there was a great loss of life, the disaster proved the value of wireless.



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An announcer in the London headquarters of an American broadcasting system about to go on the air for an on-the-spot report of a bombing. Radio has brought the people of the world closer together.

Almost as soon as wireless was perfected, inventors began trying to make it talk. They wanted it to carry conversations, like the telephone, and not merely code letters, like the telegraph. During World War I, the wireless was given a voice. Many inventors contributed. Probably the most essential invention was a tube made by an English scientist, Sir Ambrose Fleming, in 1904. An American, Lee De Forest, added another part to the tube in 1906. Without this addition it could not have been used as a radio tube. You will have to study science before you can understand how the tube works.

Experimental broadcasts were made earlier, but real broadcasting began in 1921. When we think about radio, we usually think about programs—music, plays, and other entertainment. They, of course, are

forms of communication, but think of what radio has done to spread the news.

Today you do not even have to wait for newspapers with columns of telegraph news. All you need to do is turn on the radio. There are news broadcasts every little while, all day long. Some news programs bring you the words of reporters from all over the world. Some news events are reported while they are going on, and you can hear the actual sounds. You can hear the bands play and the spectators cheer at a football game miles away. You can listen to speeches made anywhere in the world.

It is because of radio that you can pick up your telephone and talk to someone in Russia or Australia or even on a ship at sea. Your conversation is carried part way by telephone wires and part way by radio.

A WORKSHOP ON TRANSPORTATION AND COMMUNICATION

Add to your time chart the new dates you find in this chapter. Put them in a third column headed "Transportation and Communication." You see that by 1890 people had steamships, railways, and the telegraph. These means of transportation and communication had already been in use for many years. Submarine telegraph cables made it possible to communicate almost instantly with people on other continents. Telephones were coming into fairly common use, although they were still rather crude.

Our ancestors of 1890 wrote much about the marvels of modern science. They believed that transportation and communication had gone about as far as they could. There would be small improvements, of course, but all possible basic inventions had been made. Were they right? What was to come that they knew nothing about?

Do you believe that all basic inventions have been made in our own time? When you have answered that question for yourself, ask other people what they think. A good many people do believe that almost everything is known now. Could they be as wrong as the people of 1890? You might enjoy talking about that in class.

Here is something else you might discuss. The people of 1890 considered their best trains and ships the last word in comfort and convenience. Were they right? Do you suppose our means of transportation have reached the highest possible level of comfort and convenience? Have you any ideas for improving them? If they are ever improved, someone will have to do it. You might be the one.

Your Community as a Laboratory

Your parents may be able to remember when there was no radio. Certainly your grandparents remember the time well. People who are only middle-aged can remember when there were no airplanes. Older people remember when there were no automobiles, and many people now living remember when there were no telephones.

You can find people in your own community to tell you about the early days of

each of these inventions. Ask them if they remember what the community was like earlier and what changes were brought by each invention.

No one now living remembers the time before railways, but perhaps you can get some secondhand stories from older people. As children, many of them talked to people who lived before there were railroads.

TRANSPORTATION

IN YOUR COMMUNITY

How do people get about in your community? How are goods brought to your community and taken away? How do you get to school? Do members of your family need to use any kind of transportation to get to work or to the stores? Find out all you can about transportation within your community, then about how your community is connected with others. You should know your own region's roads and railroads.

Everyone should know how to use road maps and the maps in railroad timetables. You will learn best by getting the actual maps and planning trips. You can get highway maps at service stations and railroad maps at the railroad station. Choose places you would like to visit and plan how to get there. Plan your trips as carefully as if you really meant to go.

COMMUNICATION

In the section on telephones, nothing was said about how telephones are connected—about how you get the number you call. The best way to learn about that is to see how it is done. Every community has a telephone exchange. Your class can probably get permission to visit your local telephone exchange. There someone can show you how connections are made for local and long-distance calls.

You can probably arrange to visit the telegraph office to see how messages are sent and received, the newspaper office to learn how papers get their news, and the post office to see how letters are sorted. If your town has a broadcasting station, you would surely like to see a broadcast.

LISTEN TO THE RADIO

How many times a day can you get the news on your own radio? Listen to some of the news broadcasts. Find a program, if you can, that brings you news broadcasts from other countries.

Besides general news broadcasts, you will find broadcasts of many special events, from ball games to speeches. There are programs with information of special interest to farmers, programs that tell about advances in science, and programs in which people discuss topics of general interest. There are also programs for schools.

Listen to as many different kinds of programs as you can for a few days. Perhaps you may find a few of them dull, but they must interest a good many people. If they did not, the broadcasting companies would not put them on the air. You should know what information your radio has for you. You may even like some of the programs that you did not expect to find interesting.

Test Your Skill and Knowledge

Most forms of communication depend upon the use of words. New ideas call for new words. That is why you have needed to learn new words as you read this book. The word *communication* itself may have been new when you first saw it in this chapter. *Ocean current* is another term that may have been new to you.

In the following activities there are suggestions for reports. When you make yours, see how well you can communicate your ideas to the rest of the class. Try to use words correctly, to stick to the point, and to explain clearly just what you mean.

A MAP-READING ACTIVITY

Did you notice anything unusual about the maps on pages 279 and 280? Do you see how the continents appear to be stretched in the high latitudes? A map draftsman would say they were drawn on the Mercator projection. A projection is a plan for drawing a map. The draftsman starts by drawing lines of latitude and longitude. He has a choice of several ways of drawing them, and not one of the ways is correct. The earth is a sphere and a piece of paper is flat. On

paper there is no way of drawing the latitude and longitude lines so that they will truly represent their position on the earth.

The map is drawn according to the latitude and longitude lines. All properly drawn maps are correct in respect to latitude and longitude. If a map says that a place is 40 degrees north and 75 degrees west, then that is where it is, and you can count on it. You cannot count on anything else unless you know what the map was intended to show.

Most of the maps in this book were drawn to make land areas correct. You have used them to compare areas, and so a projection was chosen that showed areas correctly. On some, for example the world map on pages 362-363, water areas are correct, too. To make them correct, the map had to be cut into scallops. Directions are not straight lines except due east and west. Such maps would be almost useless for a navigator trying to plan a course for a ship.

Once, the Mercator projection was used for all purposes, and people got very wrong impressions about the earth. For example, Greenland appears to be wider than South America at the Amazon. The Mercator projection is drawn with all lines of latitude and longitude straight. If the map were drawn to show the whole earth, the poles, which are only points, would be lines as long as the line representing the equator.

When geographers began to talk about the faults of Mercator maps, many people got the impression that the projection was not good for anything. Navigators always knew better. Charts (special maps for navigators) are drawn on the Mercator projection because the navigator must lay out a course that a steersman can follow. It must be expressed in terms of compass directions because the steersman must use a compass to tell in what direction the ship is headed.

In your earlier years of geography, you learned that north is always straight toward the North Pole. You were given questions about places east and west or north and south of each other, and you found the answers by following lines of latitude and longitude. Besides these directions marked by lines of latitude and longitude, you were asked to learn only the halfway directions, such as northeast. Sailors use a whole series of directions between north and east.

First use the map on pages 362-363 to answer the following questions. Write down

your answers, and then check them with one of the maps on pages 279 and 280.

1. What direction is Iceland from the western tip of Africa?

2. What direction is Australia from California?

3. Is any part of Greenland farther west than the west coast of South America?

4. What direction are the British Isles from Central America?

5. What direction is Italy from northern Norway?

For the second half of the activity, choose the larger area from each of the pairs listed below. Use first one of the maps on page 280; then check your answers by the map on pages 362-363.

6. Iceland or Italy?

7. Australia or Alaska?

8. Australia or Arabia? (Notice the latitude of both these areas.)

9. Africa or North America?

10. Hudson Bay or the Gulf of Mexico?

CAN YOU EXPLAIN?

At the present time, ships usually steer fairly close to a great-circle route between ports. A great-circle route, as you probably know, is the shortest distance between two points measured on a globe. The navigator really breaks the great circle down into a series of straight lines on the Mercator map so that the course can be steered by the compass; but in general, ships take the shortest possible course. Three to four hundred years ago, ships often went a long way round to reach their destination. They also met many difficulties that do not bother modern seamen at all.

From maps on pages 279 and 280, explain as well as you can the strange behavior of the ships described in the following paragraphs.

1. From Mexico to the Philippine Islands, ships once sailed almost straight west. Returning, they sailed north to about the latitude of Japan before they turned east. Why did they go so far around?

2. About 1770, the people of New York complained to the authorities in London that English ships coming to New York took two weeks longer to cross the Atlantic than New England ships required. A New England captain in London was consulted. He ex-

plained that New England captains knew something about the Atlantic Ocean that the English captains did not know. As a result of their knowledge, they sailed farther north on the westward voyage. Why was it easier for them to sail west in the higher latitudes?

3. Early Portuguese navigators planning to sail eastward around the southern tip of Africa started out southwest from Portugal. Sometimes they went far enough west to sight the coast of South America. Then they went south and, finally, east past Africa. Why do you think they followed this course?

4. Sailing ships going from the Atlantic to the Pacific were often delayed for weeks trying to get around the southern tip of South America. What do you think they were waiting for? (Remember that winds do not always blow from one direction, even in the belts of prevailing winds.)

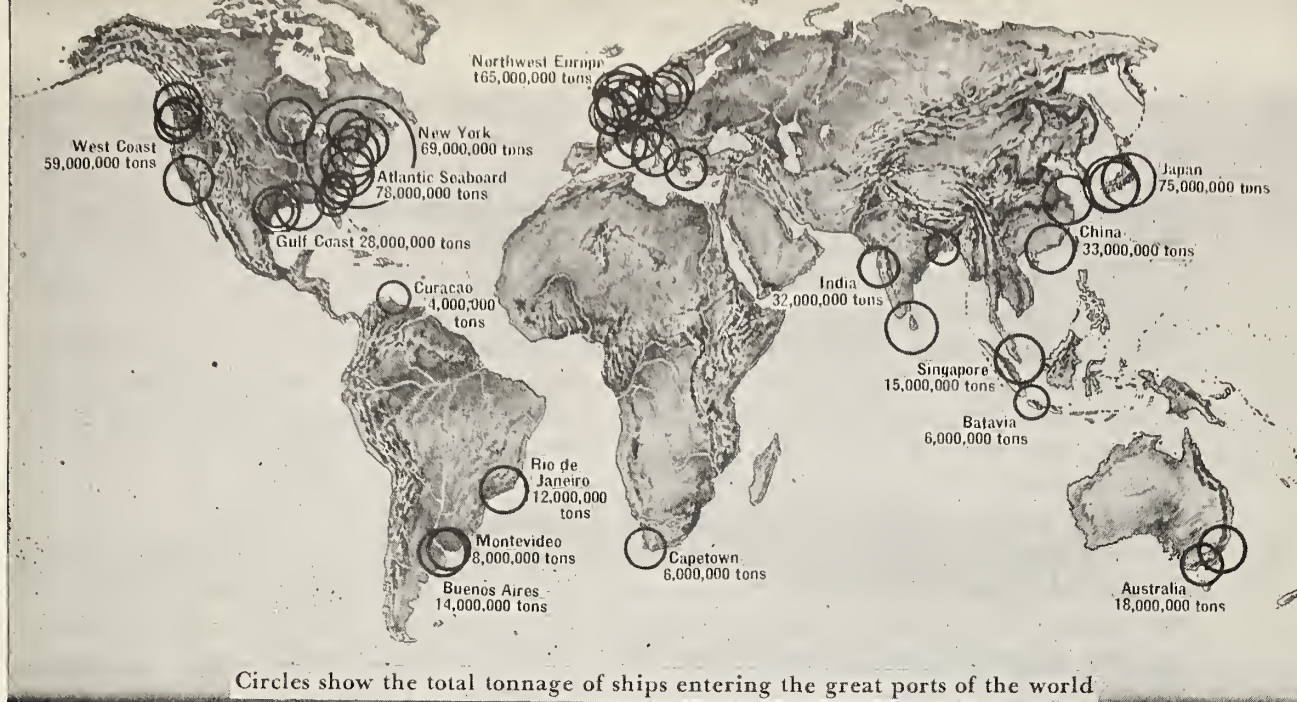
USE THE INDEX

You have now learned about the sources of raw materials, how they are processed, and the means of carrying them from place to place. You did not find all the information on any one subject in one section of the book. In this chapter, for example, you have been reading about trains and railroads. You read about them in earlier chapters, too. You read about wheat and beef in the farming chapter, in the manufacturing chapter, and in this chapter. You read about population distribution in every chapter.

With your teacher's help, choose a subject for a report. In addition to the ones just named, you might choose fish, lumber, petroleum, coal, a metal, cotton, wool, dairying, tropical products, airplanes, ships, or any one of a number of others. Use the Index to find the information you need. Do not use any references beyond page 300. All members of the class should hear or read each report. The reports will serve as a review before you begin the next chapter.

ADDITIONAL INFORMATION

It has already been suggested that you get highway and railroad maps. Most railroad companies, air lines, steamship lines, and automobile manufacturers have booklets, folders, and charts that they will be glad to send if you write for them. Some have materials especially prepared for schools.



Merchants and Traders

A KNIFE FOR A NECKLACE

Have you ever done any trading? If you are a collector of stamps or coins, you have probably traded duplicates with other collectors. If you carry your lunch to school, you have probably traded sandwiches or cookies sometimes. People have always wanted something they did not have more than they wanted something they had.

From far back in the Old Stone Age there is evidence of trade. Shells that were evidently admired as ornaments have been found all over Europe. Many of them have been dug up with skeletons of Old Stone Age people. The positions in which they have been found indicate that they were strung and worn as necklaces. The shells could have come only from the seashore.

Flint for knives, axes, and spearheads must also have been traded. It is not

found everywhere in the world, but nearly all early peoples had implements made of it. Many of them must have got either the flint or the finished implements by trade.

We have no way of knowing how much trade may have been carried on in food, skin garments, and other perishable articles. We do know that in such things as knives and necklaces there must have been trade. Probably no one made a business of trading. Goods were just passed on from one person to another.

By the early Bronze Age there were regular traders and trade routes. Probably in southwestern Asia real trade began as early as the New Stone Age; but, for a change, we might look at ancient trade routes across Europe. Turn to the map on page 386-387 and find the Baltic Sea. Through the

center of Europe there is an almost continuous barrier of mountains cutting off the lands bordering the Baltic from the Mediterranean lands to the south. You have read that in early times Europe was almost solidly covered with dense forests, broken here and there by tiny clearings.

Travel across this wilderness was difficult and dangerous; but traders from the Mediterranean lands did cross Europe in the Bronze Age. Only something highly valued could have led them to make the trip.

Amber was the article that drew traders across Europe in prehistoric times. Amber is the hardened resin from a kind of pine tree that once grew around the Baltic. Lumps of it are still washed up on the seashore. It was valued in Mediterranean lands because it was supposed to have magic properties. You learned why on page 194. When amber

is rubbed with a cloth, it attracts light objects. We know now that the rubbing generates electricity, but people of ancient times did not know why amber developed its curious aliveness. They believed that beads and ornaments of the strange substance would protect them from harm.

Some of the traders went up the tributaries of the Danube and then crossed to the headwaters of the large rivers flowing north. Some crossed from the Adriatic Sea through the passes of the Alps to the northward-flowing rivers.

Apparently the traders traveled by land, but followed the valleys because they were the easiest routes. Going north, they carried chiefly bronze knives and axes. The people on the shores of the Baltic had no copper of their own, and they valued the metal implements highly.

WORLD TRADE BY OAR AND SAIL

You already know a little about ancient sea traders and their ships. You have read about the Greeks and Phoenicians. They lived a very long time ago, but there were other traders still earlier.

Ancient Sea Trade

Before the Phoenicians even settled on the Mediterranean shore, a great seafaring people lived on the island of Crete. Cretan rulers were called Sea Kings, and scarcely an oar could move in the Mediterranean without their consent.

Even before the Cretans became traders, there were others. Ancient writers mention a sea-trading people of Asia Minor, but we have only faint hints about them. Then there are traces of an even older sea trade, perhaps as old as the New Stone Age.

The pathfinders. If we wish to start with a time when the records are clear, we must begin with the Phoenicians, who settled

between the mountains and the sea in the land that is now Lebanon. You can find Lebanon on the map on pages 390-391. The area is so small that only the abbreviation "Leb." will fit on the map.

Behind the coast rose forested mountains, leaving the Phoenicians scarcely any level land for farming. To grow food, they terraced the mountain slopes; but their real occupation was trading. Their cities were all seaports. Tyre, most famous of all, stood on an island offshore.

The little ships we watched sailing away from Ezion-Geber belonged to Solomon, King of the Hebrews, but they were manned by Phoenician sailors. By the time of Solomon, the tenth century B.C., no one even thought of ships without thinking of Phoenicians. When the Hebrew king wanted to trade on the Red Sea, he hired Phoenicians to build the ships and sail them.

You read on page 153 how Phoenician traders found their way westward to Spain and then northward along the Atlantic

coast of Europe. Others turned south along the coast of Africa and seem to have gone as far as the Gulf of Guinea. The Phoenicians never got out of sight of land if they could help it, but for all that they were daring explorers.

Ancient ships and cargoes. The Bible says (I Kings 10:22) that Solomon had a fleet of three hundred ships that sailed with the fleet of Hiram, King of the Phoenician city of Tyre. Once in three years the fleet returned to Palestine, "bringing gold and silver, ivory, and apes, and peacocks."

The passage quoted from the Bible is part of a description of Solomon's great wealth. It mentions gold, silver, ivory, and strange pets because they were costly luxuries. Luxury goods made up an important part of ancient trade, because they had high value for their size and weight; but there was trade in everyday things, too. We know that the island of Cyprus was one of the most ancient sources of copper. Ships must have carried the copper from Cyprus to other lands. We know that Phoenician ships carried tin ore from as far away as Britain. Ships towed rafts of logs to Egypt from the forests of Lebanon. The most highly valued product they took away from Egypt was papyrus paper.

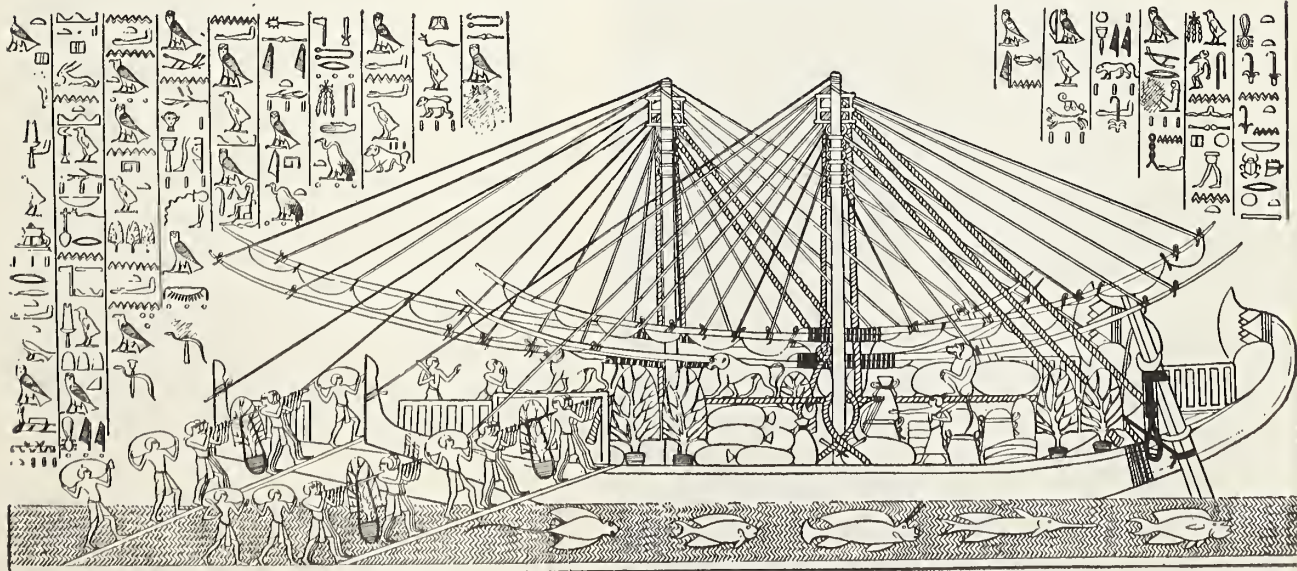
Outside of the region around the eastern end of the Mediterranean, most peoples were still at very primitive cultural levels. Beads and ornaments, mirrors of polished metal, bronze knives and axes, artistic pottery dishes and glass bottles, woolen and linen textiles brought high prices among people who did not know how to make them. With such goods Phoenician traders bought British tin and other raw materials, as well as gold and silver, ivory, apes, and peacocks for the kings' palaces.

All this early trade was carried on without money. It was truly trade—the exchange of one article for another. Coined money was not invented until a little before 500 B.C. The invention is usually credited to Croesus, King of Lydia, which was a small country in Asia Minor.

By the time money was invented, the Greeks were becoming the principal sea traders of the Mediterranean. The Greeks needed bread. Their mountainous little country did not have enough land suitable for grain. All around the shores of the Mediterranean and Black seas, Greek traders bought grain. In return they carried manufactured articles and tall jars of olive oil. Most of the people with whom they traded were not much interested in farming. These people did not raise enough grain to sell,

An Egyptian artist made this drawing of ships loading near the southern end of the Red Sea. The picture writing tells about the trip. In the cargo you can find live apes and tropical plants.

Oriental Institute, University of Chicago



and so the Greek cities sent out colonists. From the Black Sea to Mediterranean France there were little communities of Greeks. They grew grain and set up markets to which people living farther inland could bring their products.

Later the people of Italy needed more grain than they could grow. To the end of the Roman Empire, grain ships made up a large part of the traffic on the Mediterranean. Then nearly all trade disappeared, along with the rest of ancient culture.

Medieval Sea Trade

Our own culture can be traced directly back to the culture of the ancient Mediterranean peoples. Sometimes we get so interested in the development of our own culture that we forget it is not the only one in the world. While Mediterranean peoples were exploring, inventing, and learning the techniques of civilization, a number of very different cultures were growing up in Asia. Little trading ships were finding their way

A Chinese junk.

Philip Gendreau



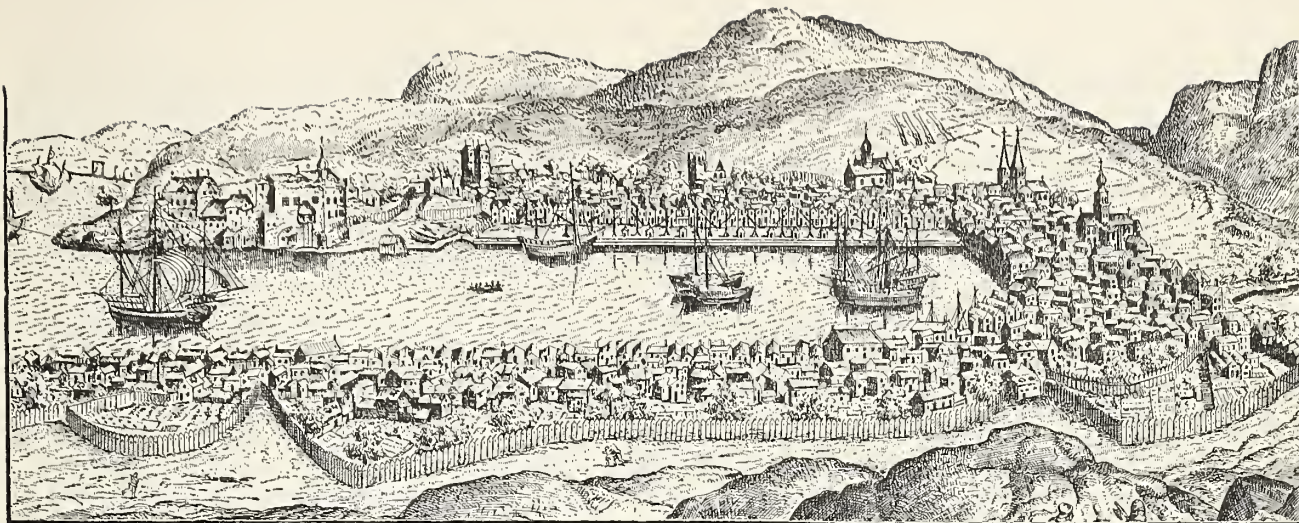
along the coasts and among the islands. The Chinese junk in the picture is a very old type of ship. Perhaps the ships of Chinese traders had begun to look like this even in ancient times. But so far as we know, no Chinese ship ever met a Phoenician or Greek or Roman ship. The East and West had no contact by sea until later.

When sea trade did begin between eastern and western Asia, goods were carried on the ships of a desert people, the Arabs. Soon after the end of the Roman Empire, the Arabs began a long period of conquest and expansion. They became the rulers of most of southwestern Asia and North Africa. They also became seamen. Their ships were longer, slimmer, and faster than European ships, either ancient or medieval.

Arab traders sailed to India from the Red Sea and the Persian Gulf. There they traded for goods produced in India, in the islands southeast of Asia, and in China. On the Mediterranean other Arab traders met traders from Venice and Genoa. Thus all goods traded by sea between the East and West passed through the hands of the Arabs. Between ports on the Persian Gulf or the Red Sea and ports on the Mediterranean, the goods were carried by camel caravan.

Medieval cargoes. The people of medieval Europe had no easy access to tropical products, and for hundreds of years their technology was far behind the technology of the workers of India and China. These two facts account for the trade between Europe and the East during the Middle Ages. Sugar and spices were the tropical products the Europeans wanted most. Beet sugar was unknown. People liked a sweet flavor as much then as now, but in Europe they got it only from honey and fruit. Sugar from India was too costly for any but the rich.

Have you ever heard the proverb, "Variety is the spice of life"? For people of the Middle Ages, the proverb might be turned around. Spice gave variety to dull foods. Pepper was worth its weight in gold.



Sixteenth-century Bergen, Norway. Bergen was one of the chief ports of the Hanseatic League, but to us it does not seem large or its harbor busy. Trade was still small compared with modern trade.

Silk and cotton materials were the manufactured articles wanted most. In the later Middle Ages, cotton was even more highly prized than silk. Silkworm eggs were smuggled into Europe from China, and so Europe had a little silk of its own. No cotton was grown in medieval Europe. Since it was scarcer than silk, it was more valuable.

Europe had few goods that the people of eastern Asia wanted in return for their fabrics and flavors. They wanted gold and silver, not the crude goods of Europe. For hundreds of years, therefore, most of the gold and silver mined in Europe were sent to the East to buy luxuries.

In the early part of the Middle Ages, northern Europe had almost no sea trade. From the ninth to the twelfth centuries, the Vikings carried on a little trade. Later, the Dutch people became the principal traders of northern Europe. Their business began with the sale of salt herring. Fish always remained important, but Dutch traders soon began to carry goods for the people of other countries. Around the shores of the North Sea they peddled English and Flemish woolsens, furs from eastern Europe, Asiatic goods that had been brought overland from ports on the Mediterranean.

Toward the very end of the Middle Ages, the merchants of a number of German cities

formed an organization called the Hanseatic League. Before long the League controlled most of the sea trade of northern Europe and much of the land trade. From the Baltic Sea to Norway, the League owned its own ports. Even in London the Hanseatic traders had their own section of the harbor down to the time of Queen Elizabeth.

Trade and world knowledge. In earlier times only a few outstanding thinkers wanted to know about the world just for the sake of knowing. No one sent out exploring expeditions to fill in an empty spot on the map; but the hope of trade led travelers to more and more remote parts of the earth.

Traders have brought home knowledge of distant places to their own people, and they have also spread knowledge along with their trade goods. The trade goods the Phoenicians carried were gone long ago, except perhaps for a few pieces on the shelves of our museums. But they carried something else that we still use every day. You are using it as you read this page.

You learned earlier about different ways of writing. In some, the symbol stands for an idea. In others, it stands for a whole word or a syllable. All of the oldest methods of writing were based on such symbols. For some kinds of writing, a person must learn

thousands of symbols. The Phoenicians used an alphabet, in which a symbol stands for a sound. Phoenicians traded in Greece at a time when the Greeks still had a primitive culture and no method of writing. The Greeks adopted the Phoenician alphabet, with changes to make it fit their language. Greeks, in turn, became traders. They traded in Italy when Rome was still a village on the Tiber. The Italians adopted the Greek alphabet, making certain changes in the form of the letters. We use a modified form of that alphabet.

Would you like to know how many people today speak languages written with symbols that can be traced back to the alphabet of the Phoenicians? Turn to the population tables on pages 349-350. Add together the populations of North America, South America, Australia, Europe, Soviet Asia, Turkey, and South Africa.

In countries where an alphabet is used, most people can read. In countries where other methods of writing are used, vast numbers of people cannot read. Learning takes too long. Imagine the difficulty of using many modern methods of communication with a system of writing that calls for thousands of characters. Think of type-

written business letters, machines to set type, and telegraph code letters. Now do you think it makes any difference to you that Phoenician traders sailed the Mediterranean three thousand years ago?

Many examples could be given of the influence of early traders upon our lives today. Greek traders spread Greek culture from the Black Sea to the Strait of Gibraltar. During the Middle Ages, news carried by traders was almost the only communication there was between distant parts of the earth. For example, King Alfred of England, who died in the year 901, was troubled by the ignorance of his people. He wrote a book for them, telling all he could find out about the history and geography of the world. In order to learn a little about eastern Europe, the king sent for the captains of trading ships.

There is no need to repeat here the story of the period of world exploration. You have read it a number of times. You know that Columbus was one of the explorers. Others traced and mapped the coasts of the Americas, Africa, eastern Asia, and Australia. Before that time the world as a whole was not known to anyone. Nearly all the explorers were looking for new trade routes or new areas for trade.

PACK TRAINS, MARKETS, AND FAIRS

In your own community there are two kinds of buying and selling. There is the large-scale trade that we sometimes call by the more formal name of *commerce*. There is also the kind of trading that goes on in the neighborhood stores. In our time we buy almost everything in stores, but this has not always been true. Medieval Europe had scarcely any stores—none at all of the kind we know. In the early Middle Ages there were very few towns. People got along with little, and most of the things they had were made at home.

Later in the Middle Ages, towns grew up again. In the towns, craftsmen had shops in

their own homes and sold their products directly to consumers. Goods were usually made to order. A person who wanted a new saddle went to a saddler and asked him to make it. One who wanted a piece of jewelry went to a goldsmith.

Goods Reach the Consumer

Towns were small, but they were crowded. For protection in the many small wars and other disorders, the towns were walled. As population grew, a town became more and more crowded, but no one wanted to live outside the safety of the wall. Along nar-

row, crooked streets, the tall slim houses looked as if a giant hand had squeezed them together so that more could be crowded into the scanty space. There might be small gardens at the back with a few fruit trees and vegetables, but medieval townspeople could not feed themselves. For food and other materials they had to depend upon farmers, just as townspeople do today. No merchants collected the goods and displayed them on store shelves. The farmers did their own selling. In ox-drawn carts or on the backs of donkeys, they took their surplus products to the guarded gate of the town. In the early Middle Ages, the farmers were stopped at the gate. Outside the walls they spread their produce on the ground, and townspeople came out to buy. Sometimes a traveling trader unloaded his pack animals among the wheat, turnips, and salt meat.

Later, as towns grew in size and numbers, market places were provided inside the walls. The towns were stronger, and the townspeople were less afraid of letting strangers inside the gates. Town craftsmen also realized that they would get more business if the market was inside the town.

Not every day was market day in a medieval town. Markets were held one or two days a week. If there were two or more towns in the same region, they usually had different market days. The people of every town wanted a chance to see the goods of any traveling traders who might be in their region. Traders knew the market schedule and laid out routes that would bring them to as many towns as possible on market days.

Few medieval farmers grew products especially for sale. They farmed to supply themselves with food. Usually there was little left over, but what little there was, the farmers took to market. They might have a little grain, a few vegetables, a basket of fruit, a chicken or two, a piece of salt beef, half a dozen eggs, or a donkeyload of hay for the town horses. They might also have gathered up a few bundles of firewood or a bag of nuts in the forest. If the wool clip had been good

and a farm woman had woven more cloth than was absolutely necessary for the family clothing, she took it to market. When the geese were plucked, there were feathers to sell. After threshing, there might be straw that the townspeople would buy for stuffing their mattresses.

With the money they got for their produce, farmers bought the few things they could not make at home. Now and then they needed a new tool from the blacksmith. Salt was a necessity that few people could provide for themselves. Salt fish for church fast days were a luxury. Most farmers could afford them only now and then. A new cooking pot, real dishes to take the place of wooden ones, a little packet of spice, a taste of sugar—these a farmer could afford only once or twice in a lifetime, if ever.

During the later Middle Ages many towns had very special markets, called fairs. Fairs came at longer intervals than ordinary markets—usually once a year. A fair lasted for several days. Merchants came to it from other towns.

Those who had goods to sell were given space in the square. There they set up stalls in which their goods could be displayed. Craftsmen in the town closed their own shops and moved their goods to the market place. Jugglers, tumblers, wandering musicians, and men with performing bears also came to the fair. They did not charge a fee, but did very well on the small coins that people tossed them. Probably the merchants of the town had also arranged for more elaborate entertainment in the form of a miracle play. Miracle plays were dramatized scenes from the Bible.

For a whole year the community would have nothing again so exciting as the fair. From the villages for miles around people crowded into the market square. It was a break in the everyday routine of poor living and hard work. It was also a chance to meet acquaintances from neighboring villages and to see strange-looking foreign merchants.



A medieval fair. Imagine the sound of the hammer, the merchants' cries, the chatter, and strains of music.

The village people gazed in wonder at marvelous things they could not afford to buy; but unless they were very poor indeed, they had saved a few small coins to spend at the fair. A treasure or two would be carried proudly home.

Medieval Land Routes

Many medieval towns had fairs. As the years passed, some became far more important than others. These fairs became famous throughout Europe. The towns grew and prospered because of the business brought by their fairs, and to this day they are some of the leading trading centers of Europe. All this did not happen by chance. You will learn the reasons as you read on.

We should call the business carried on at the fairs both wholesale and retail trade. *Retail* trade is the kind you and other con-

sumers carry on at the corner store. The storekeeper is carrying on *wholesale* trade when he buys in large lots from dealers who have collected goods from producers.

Merchants went to medieval fairs to sell some of their goods to consumers. They also went to meet other merchants and exchange goods. This second purpose became more and more important as trade increased during the later Middle Ages.

On the way to the fair. When Italian merchants bought eastern merchandise from the Arabs, they sailed back to their own home ports of Venice and Genoa. There the eastern goods were bought by other merchants, who distributed most of them over Europe by land. The map on the page facing this one shows the principal land routes that were in use in Europe during the late Middle Ages.

Not all eastern goods came into Europe by sea. Do you see the route that follows the Don River from the Sea of Azov and then runs off the map to the east? Merchants from eastern Europe followed that route eastward past the Caspian and on across the deserts and dry grasslands to Samarkand, Tashkent, and Bukhara. There they met Chinese merchants who had come with camel caravans from the eastern coast of Asia. They had followed a long, difficult trail that is called the Silk Road even today.

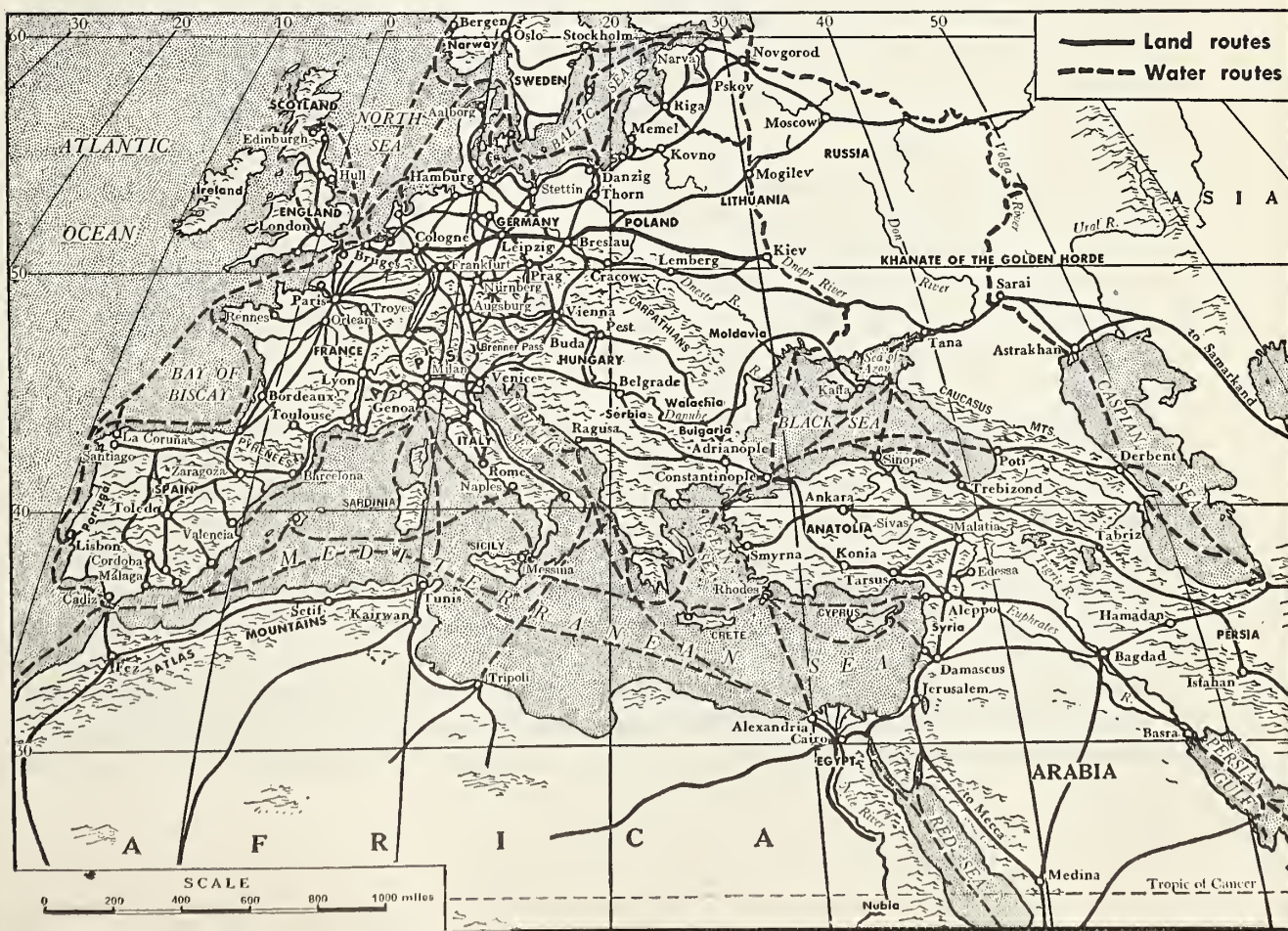
East of the Baltic, other routes run far to the north. Soft, warm furs from the forests of northern Russia were the greatest treasure carried along these routes—snow-white ermine for a king's robe, mink to keep a lady warm in a drafty castle, bearskin rugs for a cold stone floor. Beeswax came along those routes, too, to be made into the fine candles that burned in churches.

On and on these goods traveled to the fairs of western Europe. From nearer home came

fine woollens woven in Flanders, linen, copperware, and flagons of wine. Kegs of salt herring from the North Sea, bags of wool from Britain, bars of metal from mining regions, jewelry, glassware—a little of everything known to medieval Europe traveled over the highways to the fairs.

And what highways they were! Here and there remained bits of the old Roman roads, rough and broken, with grass growing between the stones. Usually, though, there were not even broken stones as reminders that Europe once had paved roads. There were only dirt tracks, deep with mud in wet weather, deep with dust when the weather was dry. Often the roads were only paths worn by the feet of horses and pack mules. Sometimes merchants tried two-wheeled carts for short distances, but the cart was likely to be abandoned in a mudhole miles from the fair. The only reliable means of land transportation was a mule, or sometimes a horse or donkey.

The chief land and sea trade routes of medieval Europe.



Rivers were used, of course. Sailboats, boats with oars, and barges or rafts to be pushed by men with poles were the means of carrying on river traffic.

Where trade routes met. Look again at the trade-route map on page 309. Find the places where several land routes met, or where a land route crossed a navigable river, or where a land route came to the sea. If you remember your study of European geography, you will recognize the names of most of the cities you find at such places.

During the late Middle Ages, many little towns grew up in Europe. Some of them are still little towns. Others prospered and became great cities. Those most likely to prosper were the cities at the crossroads. Look at Leipzig, for example. An old, old trade route ran east and west on the more level land at the foot of the Central Highlands of Europe. From Italy northward through Brenner Pass to the Baltic runs a route as old as the prehistoric amber trade. Leipzig stands where the two routes cross. From the city another route runs down the valley of the Elbe to the North Sea. Merchants from east and west and north and south met at the Leipzig Fair. It became the greatest fair in Europe.

At Paris routes met from Italy, from Spain, and from the shores of the North Sea. There and at other French fairs merchants bringing goods from Italy met Flemish merchants with woolen and linen materials and with raw wool from England.

A harbor alone does not make a seaport. A seaport must be a place where land and sea trade meet. The great medieval seaports were at the ends of important land routes. For the most part, the great seaports of the Middle Ages are still the great seaports of Europe. Railroads and highways follow the routes of the pack trails because they are still the easiest routes. They depend upon geography—upon valleys and mountain passes, level land at the foot of highlands, or places where rivers can be crossed.

Early American Trade

The Middle Ages had ended when America was settled. European trade was busy and bustling. Whether they were English, French, or Dutch, the companies that sent the first settlers to North America were trading companies. Trade was the first purpose of colonies. Here was a continent full of treasures that needed only workers to get them ready for shipment. No doubt you have read in your history books about the Dutch trading posts on the Hudson and the French fur traders who explored the interior of the continent. There were many fur traders among the English colonists, too. While the settled area was only a narrow fringe along the coast, fur traders followed Indian trails to the mountains and beyond.

There was also trade across the Atlantic. The first settlers in the southern colonies depended for a living upon the export of tobacco. Settlers in the middle colonies exported flour, grain, salt meat packed in barrels, and other food products. But the New Englanders were the early Americans who became famous as traders.

No doubt you have read often about the stony New England soil that did not prove to be good for farming. While other colonists were developing their fine farm land, thousands of New England colonists took to the sea in ships built from the trees in their forests. Some of them became fishermen. Others became traders. Among the goods in almost every trader's cargo were fish caught and salted by his neighbors.

New Englanders were nicknamed Yankees. Yankee trading ships became so familiar in all the ports of the world that people of other countries later called all people from the United States Yankees. Yankee traders were the only Americans they knew.

New England captains began by selling fish, timber, and other New England products. They brought home many raw materials—molasses from the West Indies, hides and skins from Spanish California, cotton

from the South, tea and spices from Asia, furs from the Northwest, cacao beans and coffee from South America. They brought home money, too. Some of it they made by selling the goods they imported, and some by carrying goods for other people.

When people have raw materials and money to buy equipment, they are very likely to go into manufacturing. That was what the New Englanders did, as you know. Then they had manufactured goods to sell. Yankee ships in California ports in the early 1800's were fitted up like department stores.

New England trade was not entirely by sea. As the frontier of settlement moved across eastern North America, Yankee traders set out with wagons. Over dirt tracks too poor to be called roads they peddled New England goods westward to the Mississippi and far into the South. The Yankee peddler was welcome in frontier



The Bettman Archive

The arrival of spring and the peddler, bringing goods—and news. These women would be dazzled by a modern store.

settlements all over the land. In the picture you can see some of the goods the peddlers' wagons carried. The peddlers gave thousands of frontier women their only chance to buy cloth, clocks, dishes, needles and thread, tea, coffee, and spices.

OUR GOODS GO TO MARKET

Earlier in this book you have seen commercial hunters and fishermen, farmers and ranchers, miners and workers in the manufacturing industries, all producing goods. You know that consumers go to the stores and expect to find whatever they want. For example, on one shelf in the grocery store you are likely to find canned fish from the east, south, and west coasts of the United States, and from Canada, Alaska, Norway, and Chile. Your grocer did not write to each of those places and ask to have someone send him a few cans of fish.

On your grocer's shelves you find products from all over the world. The same thing is true in drugstores, dry-goods stores, and stores of other kinds. Have you ever wondered how the storekeepers know where

to get all the goods that they sell to you and all the rest of their customers?

The producers who grew or processed the goods do not know that they are on the shelves of a store in your community. The storekeepers of your community do not know the producers. But somehow those goods get from the producers to the stores in just about the right quantities. Think about the food supply of a great city. All the people must have food every day, but housewives do not have to keep large supplies of food on hand to be sure of feeding their families. They know they can go to the store every morning and find a wide selection of food. A housewife can plan a meal before she goes to the store and be practically certain of getting all the ingredients

she needs. This is true in every neighborhood in a great city, in small towns, and at crossroads stores in the country. Doesn't it seem rather remarkable, when you stop to think about it?

The Collection of Goods

Medieval farmers gathered in the market place of the town on market days. They brought for sale whatever they did not need at home. The townspeople provided land for a market because they wanted to be able to go to one convenient spot and find a choice of various kinds of food. The market was a convenience for the farmers, too. Their customers knew when to expect them and where to find them.

The medieval market was a device for bringing producer and consumer together. As you have read earlier in this book, almost every technique and device that has ever been used is still in use somewhere. The medieval farmer was a subsistence farmer. He grew

crops mainly for his family's food and sold such small surpluses as he might have. In modern lands of peasant farmers, surplus products are sold in the same way. Villages and small towns have market places. Farmers bring to the market a little of whatever they have to spare and sell it directly to the consumers.

You have probably seen pictures of markets in Mexico and other countries that are not highly industrialized. Craftsmen as well as farmers take their products to the market for sale.

Even in industrialized North America many towns have farmers' markets. Farmers and their wives bring vegetables and fruit, eggs, poultry, and even flowers to the market. But cities do not depend upon such markets for their food supply, and few commercial farmers depend upon them as a place to sell their products.

Have you ever noticed that many people talk about marketing when they mean buying food supplies? Many food stores are called markets, too. The words have remained in the language, although the old-time market is nearly gone.

Farm people often speak of going to town to do their trading. They mean about the same thing that townspeople mean by the word marketing. That meaning for the term trading also goes back to the customs of earlier times. On pages 209–210 you read about old-time farms in America. Farmers grew crops and raised animals mainly for their own subsistence. Farm families were well fed, but they had very little money. They wanted to buy sugar, spices and flavoring, tea and coffee, crackers and cheese, salt fish, dried fruit, and dry vegetables such as beans. On Saturday afternoon, usually, the family packed up all the butter and eggs they could spare. According to the season, there

Hannibal, Missouri, as it probably looked when Mark Twain was a boy. Old-time farmers traded in little towns like this one.

*David O. Selznick Production
from Ewing Galloway*



might also be a bushel of apples, peaches, or tomatoes, a tin pail of lard, or a bag of nuts from the woods.

At the store, the storekeeper figured out the money value of the products, but he did not give money to the farmer. The farmers did not want money. They wanted to trade their products for other goods. If their products were more than enough to pay for what they wanted, the storekeeper gave them credit for the rest. They could use it the next time they needed to buy something. If their products were worth less than the goods they wanted to buy, the storekeeper kept a record of what they owed. They would pay the debt with more products the next time they came to town.

The storekeeper sold the farm products to the people of the town. If he collected more than the townspeople wanted, he shipped the rest to the nearest large city. Supplies for cities came mainly from farm products taken in trade by hundreds of country and small-town storekeepers.

Goods for sale. Such simple methods of getting goods from producer to consumer would not do today. Look at the graphs for 1840 and 1940 on page 381. In 1840 most of the people of the United States were in the families of food producers. The food producers could easily feed the rest of the population from what they had left over after meeting their own needs. In 1940 more than four-fifths of the people depended upon less than one-fifth for their food. The food is grown chiefly by commercial farmers on mechanized farms. It is grown for sale.

Food is only one example. Farmers also produce textile fibers for clothing and raw materials for many industries. These products are all for sale. Some will be sold several times before they reach the consumers. Hunters, fishermen, forest workers, and miners, besides the farmers, all produce goods for sale. Of these, only the hunters and fishermen use any of their own products. Manufacturers all make goods to sell.

Look again at the graphs on page 381. Compare the percentage of workers in trade in 1940 with the percentage in 1840. Look through the graphs for other countries and see whether these general statements are not true. In industrialized countries, the percentage of workers in trade is high. In agricultural countries, the percentage of workers in trade is low.

You already know quite a little about modern trade. Many times you have read about farmers and other producers sending their goods to market. That, you see, is another use of the word market. When a farmer or a manufacturer markets his products, he does not send them to an actual market place as the medieval producer did. The term means just a little more than merely saying that he sells his products. The market for his products is wherever he can sell them. Marketing does carry with it the idea that he takes or sends his products somewhere. Transportation is necessary for trade. Communication is necessary, too. Sellers must know where to find a market, and buyers must know where to find what they need. A good many of the workers represented in the transportation and communication columns in the graphs are needed to keep goods moving between producers and consumers.

Where the producer sells his products.

Do you know the purpose of the four tall buildings in the picture on the next page? From those buildings you should be able to recognize that the picture was taken in a wheat-growing region. The buildings are elevators for wheat. Elevators are as characteristic of a wheat region as piers are of a seaport or blast furnaces of a steel mill.

The elevator in the nearest town is the first step between the wheat farmer and a loaf of bread on the grocer's shelf. In his own truck the wheat farmer takes his grain to the elevator. The manager of the elevator buys the wheat, and the farmer has nothing more to do with getting the grain to market. The manager must be an expert

judge of wheat. Before he buys a farmer's crop, he takes samples from the truck and grades them. Too many weed seeds or too many shriveled grains lower the grade and lower the price the farmer gets. The elevator manager knows varieties of wheat, too. As you read on page 218, different varieties are used for making different products. At the elevators the various kinds are kept in separate bins.

The manager of the elevator may sell some of the wheat to milling companies and other buyers, but usually his job is just to collect the wheat from the farmers. He grades it, sorts it, and sends it on in carload lots. From the great wheat belt of North America, almost the whole crop is shipped toward the east. Moving the wheat crop is one of the biggest jobs of American railroads. Weeks before harvest in any region the railroads begin to bring in empty boxcars. Long rows of them are soon waiting on sidetracks near the elevators.

Turn to the map on pages 374-375 and find the row of cities between 90 and 100 degrees west. Wheat is one of the products that have made those cities grow. All of them are marketing centers for wheat. From the smaller elevators in country towns wheat is collected in huge storage elevators in the cities. There it is kept until it is ordered by flour-milling companies, manufacturers of cereal products, or exporters. Most of the cities have large flour mills, too. Buffalo,

New York, is also a great flour-milling city. Wheat is shipped to Buffalo on specially designed lake steamers.

Ways of getting other farm products to market were mentioned earlier. Almost every cotton-belt town has offices of cotton buyers. On page 228 you read that cotton is collected in warehouses, where the bales are graded. From these warehouses, manufacturers buy the grades they want.

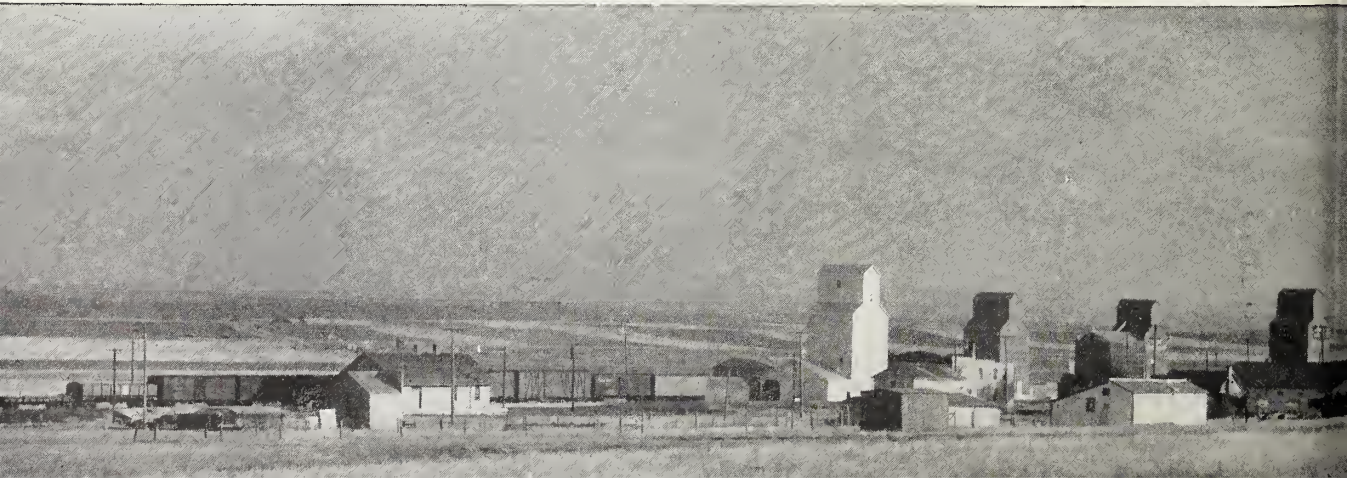
You read on page 214 about the stockyards to which meat animals are shipped. Farmers and ranchers may take their animals to the stockyards by truck. Even when the animals are shipped by cattle car on the railroads, the owner, or an employee of the owner, often goes with them. In the stockyards area of Chicago or any other great livestock market, cowboys in wide hats and high-heeled boots are a familiar sight.

Near the stockyards are the offices of buyers. These men buy many animals from many farmers and ranchers. They can sell to the packers in large lots of the same type of animal—for example cattle of about the same age and weight.

Collecting, grading, and standardizing farm products is a necessary job. The medieval housewife went to the market, looked over all the products offered, selected the best she could find, and bargained with the farmer over the price. The next housewife took the next best. The last one to come might get the poorest quality and have to

A marketing center for Montana wheat. Throughout the North American wheat belt there are communities like this—small towns with tall elevators rising above the other buildings.

Library of Congress



pay the highest price. When we go to the stores, we find many grades and many brands. We expect all products with the same label to be about the same in quality. We do not always buy the choicest kinds, but when we buy products of a lower quality, we expect to pay a lower price for them.

Nothing the processor can do will make all bacon or all canned asparagus equally good. The best machines and the most skilled workers cannot make fine white sheets out of short-fibered, badly discolored cotton. The processor must be able to buy graded and standardized raw materials in order to turn out standardized products.

Very large companies, manufacturing many different grades of product, may have their own buyers and do their own sorting. Farmers may belong to large associations and hire someone to grade their products. More often that is the job of a man who is in business for himself.

The dealer who collects farm products must usually be equipped to store them. The man who deals in grain must have a storage elevator. The cotton dealer must have a large warehouse. The livestock dealer rents pens in the stockyards.

Some farm crops, especially fruit and vegetables, are marketed in another way. Several times you have read about farmers growing crops under contract to a processor. For example, the owner or manager of a canning factory may make contracts with farmers. A farmer agrees to grow a certain number of acres of tomatoes and sell his whole crop to the canning factory. The contract may require the farmer to grow a certain variety of tomatoes and give them the care necessary to meet definite standards of quality. Thus the canner gets standardized raw material and can turn out a standardized product. Canners, freezers, and companies owning



*Hawaiian Pineapple Company
from Kaufmann & Fabry Company*
Cans and cans of pineapple, packed in cartons, are being sent to market. Soon they will appear on grocers' shelves.

chains of grocery stores make such contracts with farmers. The grower benefits by being sure of a market for his crop.

The marketing of farm products is especially complex. For example, the cotton crop of the United States comes from more than a million farms. Wheat, hogs, cattle, milk, wool, and other products must be collected from the millions of commercial farmers and ranchers of the world. A few tropical products are marketed in other ways. They are the crops raised on the large plantations you have read about several times.

The picture on this page shows cases of canned pineapple being loaded on a ship in the Hawaiian Islands. One company owns thousands of acres of pineapple plantations on the islands. The company has its own canning factories. Pineapples and pineapple juice are canned in large quantities under the brand names of the company.

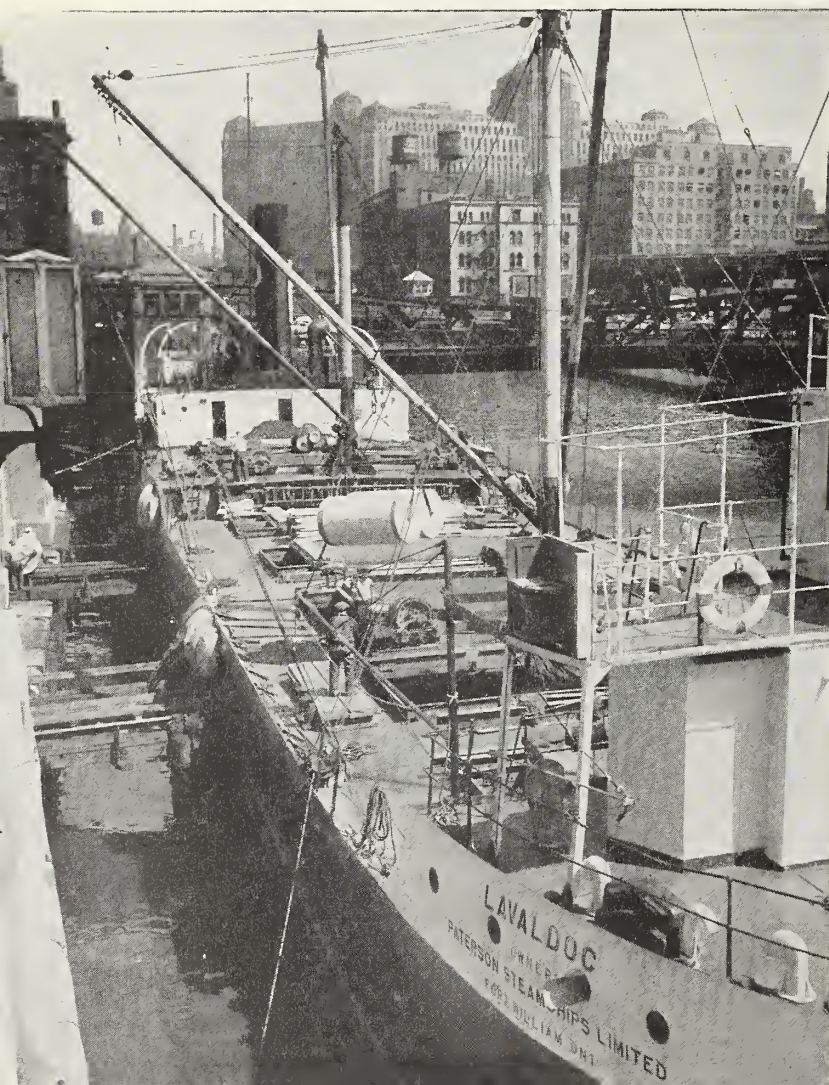
Another large American company was organized years ago to grow bananas. Men hired by the company bought thousands of acres of land in Central America, cleared them of tropical forest, and set out banana plantations. Bananas were almost unknown outside the tropics before this company began

its work. Other growers have followed their example, but the same company still supplies a large share of the bananas eaten in America and Europe. The company owns its own ships, many of which also carry passengers and other goods besides bananas. It has its own piers in a number of seaports and its own warehouses for storing and ripening the bananas.

In this book you have learned a little about the marketing of many products. Commercial hunters in the Far North take their furs to trading posts. They could not be commercial hunters if fur companies had not built the posts and sent traders to buy the furs. They have no other way of marketing the skins they have collected.

A lake steamer is unloading a cargo of paper bought directly from a Canadian paper mill by a Chicago newspaper.

Chicago Daily News Photo



Many commercial fishermen own their own boats and are in business for themselves. They sell their fish in city fish markets or at canning factories or freezing plants or to processors who prepare other fish products. There are also many large companies that hire fishermen to fish for them.

So far you have been reading mostly about commodities that can be produced by one worker alone or by a small group, such as the crew of a fishing vessel. Other goods cannot be produced efficiently without much costly equipment and the coöperation of many workers. This is true in general of the products of forests and mines.

A few farmers cut down trees on their own land, trim the logs, take them to the nearest sawmill, and sell them. The mills operate by buying a few logs from each of many producers. Such mills are usually small. As a rule, they supply their own communities with part of the lumber needed, but all together they contribute only a small fraction of the world's lumber supply.

Most lumber is produced by large companies. A company owns timberland or pays for the right to cut trees on government-owned land. The company hires lumbermen to cut the trees. It hires men to transport the logs, usually by truck, to a company-owned sawmill. Such a company has a large enough production to grade and standardize its own products. It sells directly to building contractors and lumber dealers.

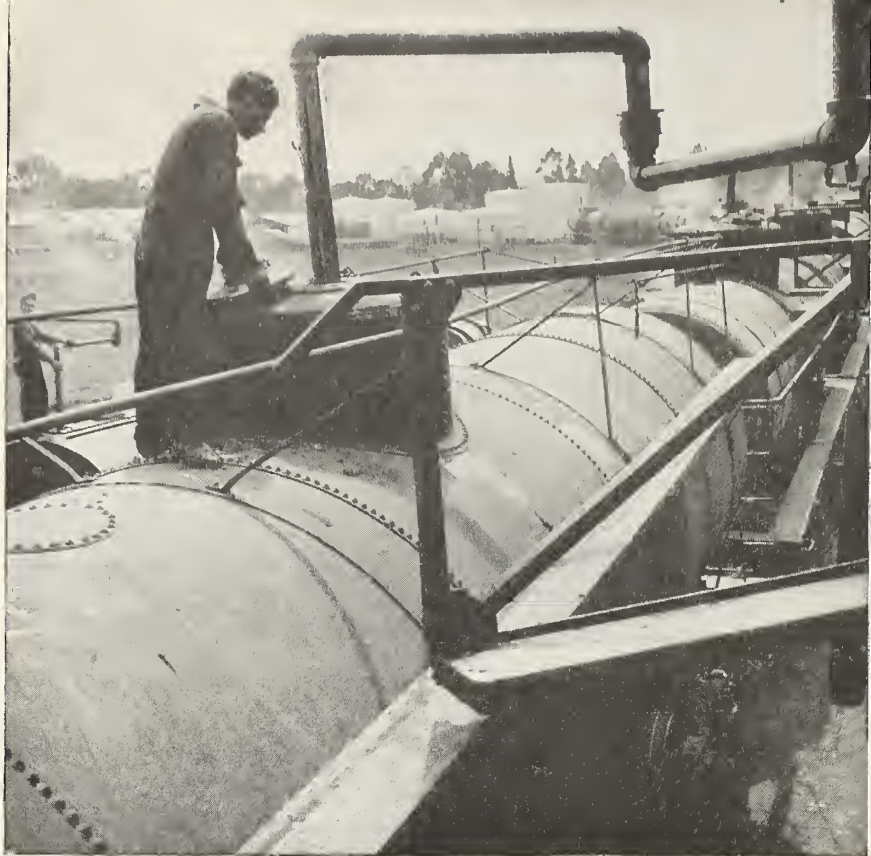
As you know, pulp and paper mills must have logs as raw material. Some have their own forests and others buy logs from lumber companies. Logs that are too small or too crooked to make good lumber can be used for making pulp.

Most ore from mines does not really go to market at all, as we ordinarily use the term. For example, most steel companies have mines of their own. They sell bars of pig iron from the blast furnaces, steel ingots, partially finished products such as sheet steel to be used in other factories, and such finished products as rails and beams. Most metal-mining companies carry the processing of ore at least as far as bars and ingots.

Many large manufacturing companies do their own collecting of materials from producers. On pages 258-259 you read a little about the collection of materials for an automobile factory. Dozens of products from farms, forests, and mines go into every car. However, most of the raw materials for the automobile industry are the finished products of other industries.

One industry is often the principal market for the products of another industry. For example, tanneries are the market for animal hides and skins from the meat-packing plants. The shoe industry, in turn, is the market for a large part of the leather produced by the tanning industry. It is also the market for manufacturers of special kinds of thread and nails, metal eyelets, shoe laces, wooden lasts, and special kinds of glue. A number of other products go into some kinds of shoes—fabrics, buckles, thin sheets of plastic, strips of steel, ground-up cork, rubber shaped for soles and heels, wooden heels. Other industries manufacture special machines and special tools for the shoe factories.

Transportation. Trade and good transportation have grown up together. Think of the difference between the goods that could be carried on a train of pack mules and those that can be carried on a modern freight



Fritz Henle

Loading tank cars at a Mexican oil field. A tank car is one kind of highly specialized freight car.

train. There is no comparison in speed or in quantity carried. If we still had to depend on pack trains, or even wagons, most of us would still be farmers. We could not have great industrial regions, because the workers in the industries could not get enough to eat. Even if the workers could be fed, there would be no way for the factories to get raw materials or fuel and no way to market the products.

Not much has been said about one characteristic of modern transportation. That is specialization. You do not really need to be told much about it, if you stop to think. If you live near a railroad, watch the freight trains that pass. There are open cars loaded with coal. They are specialized for easy loading and unloading. The coal slid down a chute into the open top. When unloading time comes, the coal will be dumped from the bottom of the car. Then there are cattle cars, with sides made of



Courtesy Northern Pacific Railway

Icing refrigerator cars. The ice-filled compartments will chill the shipment until time for the next icing.

open slats so that the animals can get fresh air. Tank cars carry petroleum products, other chemicals, and milk. Their contents were pumped in through pipes and will be pumped out again. Flatcars have machines braced and strapped in place on them. Here is a whole row of refrigerator cars, filled with meat, fruit, or vegetables. They are well insulated and have special sections to hold ice. Besides these specialized cars, there are many ordinary boxcars loaded with a variety of products.

Trucks, too, are specialized. On the highways you can see refrigerated trucks, long trailer trucks especially built to carry automobiles, trucks for transporting livestock, and other kinds.

Then there are very special types of transportation for special products. Pipe lines carry petroleum and petroleum products halfway across the continent. On the Great Lakes there are hundreds of boats designed for the easy loading and unloading of iron ore. They never carry any other cargo. Electric wires and cables are highly specialized means of marketing power.

In the marketing of products, you see what is meant by the advancing level of technology.

Improved techniques in manufacturing would have been useless without improved transportation. Commercial farming, too, would be impossible without good transportation. Improvement in one field always depends upon improvement in another.

The Distribution of Goods

You have seen how products are collected, graded, sorted, standardized. You have seen how some of those products go as raw materials to factories. Still you have not seen how goods get to the stores in your town, where you and your neighbors can go to buy them. How goods get to your community for sale depends principally upon the kind of goods they are.

Selling by the producer. Going back to the Middle Ages, you saw that it was the general practice for the producer to sell his own goods to the consumers. The farmer with his donkey or cart in the market place, the craftsman in his workshop—each sold to the consumer the product of his own work.

In our time, selling is not often so simple as that, but there are still producers who sell their own products to consumers. For example, look at the automobile service stations in your town. On each one is the name of an oil company. At any service station you can buy several grades of gasoline, various kinds of lubricating oil, and perhaps Diesel fuel, but they are all products of one oil company. If you do not like the brand, you have to go to another service station to get something different.

No owner of the oil company comes to your community to sell gasoline and oil. The man who operates the station may be your next-door neighbor. He himself may own the station, but he is still an agent of

the oil company. He has signed a contract to sell the products of that company and no other. He may have a few other things to sell, such as spark plugs and candy bars, but they are side lines. He is there to sell petroleum products to consumers, and he sells them as agent of the oil company.

The company has oil fields where the oil is pumped from the earth. It has its own refineries where the petroleum is broken down into its many products. The refineries may be near the oil fields, or they may be far away, nearer the densely populated regions where many customers are to be found. Either the crude petroleum or the petroleum products may be pumped through pipe lines owned by the company, or the company may pay for the transportation of its oil by pipe line just as you would pay to ride on a bus. The products go to central distributing points over the country. There they are stored in tanks. Then in the company's own tank trucks or in tank cars on the railroads, the products go to the company's agents who operate service stations like the ones in your community.

Automobiles, too, are usually sold by agents of the manufacturer. Only dealers in secondhand cars have all makes of automobiles. The business belongs to the agent. He is not paid a salary. The manufacturer sets the price of the car and advertises it at that price. The dealer cannot charge

more, except the cost of transportation from the factory to his showroom. The manufacturer also sets the price the dealer must pay him. The difference between the price the dealer pays the manufacturer and the price he gets from the customer is his profit. His profit is his pay for keeping cars on display where people can see them and where they can try them out and buy them most conveniently.

Wholesale and retail. The method of selling automobiles and petroleum products is a little unusual. Only a few of the merchants of your community are agents of producers. The grocery store, the drugstore, and the hardware store have products from hundreds of different producers. Even in the same type of article, the storekeeper probably has the product of several different manufacturers. For example, your grocer probably has on his shelves two or three different brands of canned vegetable soup. Some people prefer one and some another. He is not the agent of the soup manufacturers or of any other producers.

How does he get those products he sells? The whole story is too long to tell here. Keeping a grocery store stocked is more complicated than keeping most stores stocked, but in some ways it is more interesting. Suppose we see how it is done in a great city—New York, for example.

Loaded freight cars crossing the Hudson from New Jersey to New York on a barge. Few railroads can take freight cars directly to Manhattan Island by bridge or tunnel.

Pennsylvania Railroad





Philip Gendreau

These men work when other people sleep. This is a scene in the early morning hours at a wholesale market in New York.

You last saw the farmers' products being collected, graded, and packed for shipment. Some of them were on their way to processors. Others, especially fresh fruits and vegetables, needed no further processing. By truck, train, and even by ship and airplane, tons and tons of those products have been moving toward New York. Most of them must travel swiftly or they will spoil. Fresh supplies must reach the city every day. In the city, they must be unloaded quickly and they must reach the stores quickly.

So that fresh foods may be handled quickly, every large city has a huge wholesale produce market. New York's produce market is near the lower end of Manhattan Island. Some foods coming to the city have been ordered in advance by wholesale dealers. Others are bought in large lots before they are unloaded.

Night is the busiest time at the market. Freight cars are unloaded, and trucks rumble through the quiet streets. Some of the trucks have come from farms within a night's drive of New York. Refrigerator trucks bring products from farther away. Some products, such as potatoes, can stand a long trip without refrigeration.

California oranges are being unloaded from the truck in the picture. The truck may have brought them from a railway freight yard or from a pier, depending upon whether they reached New York by train or by ship.

Each wholesale dealer rents space in one of the big market buildings. The dealers specialize in one or a few kinds of products. They do not display their goods as a retail grocer does, but they do arrange them so that buyers can look them over. Many grocers go to the market or send an employee in the very early morning, long before daylight. Others order by telephone. Each wholesale dealer has his own customers. He knows about how much they will buy each day and the quality of the produce they will want. Thus he knows how much he needs to have on hand.

Other items in the grocer's stock come to the store directly from the processors. The trucks of dairy companies deliver milk, cream, butter, eggs, and cottage cheese. Trucks from bakeries bring bread and other bakery products. Like fruits and vegetables, these foods must be delivered fresh every day.

Most of the canned, boxed, and packaged goods pass through the hands of a wholesale grocer. The next time you are in a grocery store, look at the labels on the cans and packages. Count the number of different processors who have contributed to the stock in one small section of the store. Do you think your grocer would have time to write letters to all the producers and order those goods? He would have to hire several people to do nothing else. The producers do not have time for that kind of business, either. They also would have to hire a staff of people to fill the thousands of small orders. For both producers and neighborhood grocers it is simpler to let the wholesaler handle

this part of the work. He buys in large quantities from the producers. Perhaps he buys some of the goods in bulk and has his own workers package them. Then when he gets an order from a grocer for a dozen cases of one brand of canned asparagus and two cases of another brand, for a few packages of a dozen different cereals, for a little each of a hundred products, he has the exact order packed and delivered to the store.

The wholesaler does not do business just with the grocers in his own city. He gets orders from grocers in towns for miles around. He may ship the goods by freight, express, or in his own trucks. A great many of the large trucks you see on the highways are carrying goods from wholesale dealers to the retail dealers in other towns. They are not all carrying groceries, for other products are handled in the same way.



Philip Gendreau

Big trucks like these bring most of the goods from the wholesalers to the retailers, who, in turn, serve you.

Small-town storekeepers usually order from wholesalers in the nearest large city. Each large city, therefore, has its own marketing area, with quite definite boundaries. The shape of the marketing area is determined by the highways and railroads that radiate out from the city.

WORLD TRADE BY SHIP AND PLANE

A ship was tied up beside the one long pier of a little southern seaport. Railroad tracks ran out to the end of the pier. On the tracks stood flatcars loaded with clean yellow-pine lumber. A small locomotive waited to push the cars into place beside the ship as they were needed.

Extending out over the cars from the deck of the ship was a derrick-like boom. A strong steel cable dangled from the boom. The cable divided in two toward the free end. Men climbed onto one of the freight cars and fastened two pieces of rope around a large bundle of boards. Then they hooked the cable ends to the rope and waved their arms as a signal to a man on the deck of the ship. A small engine began to chug rapidly, with little puffs of steam. The bundle of boards rose into the air. When it was high

enough to clear the side of the ship, the boom swung inboard. It stopped when the boards were poised over a wide-open hatch in the deck. Then the steel cable rattled through a pulley at the end of the boom, and the bundle of boards sank into the hold of the ship. There members of the crew released the boards, stacked them neatly, and secured them for the long trip.

A Dutch flag flew from the mast of the ship. She was a tramp freighter, loading southern pine for Buenos Aires. South America has some of the largest forests in the world, but it was easier for the people of Buenos Aires to get lumber cut in Louisiana than to get lumber cut along the Amazon or in the interior of South America.

The cargo last carried by the Dutch ship was coffee from Brazil to New Orleans. In



© Screen Traveler from Gendreau

A boom, swinging barrels of oil onto a tramp freighter. Carloads of paraffin on the pier await loading.

New Orleans the captain of the ship had signed a contract with the lumber exporter to go to the small port empty, pick up the cargo, and take it to Buenos Aires.

Before taking the coffee to New Orleans, the ship had carried a cargo of English cotton materials and crated machinery to Brazil. Before that, it had taken a load of Australian wheat to England. Before that, it had taken a load of petroleum from Borneo to Australia. Before that it had carried a mixed cargo to Borneo. It had picked up part of a cargo of canned fruit, vegetables, and fish in Portland, Oregon. Then it had stopped at the port of Los Angeles for oil-well machinery, iron pipe, and steel drums to hold petroleum. Whenever a cargo was unloaded, the captain of the ship looked about for another cargo to take somewhere else.

Carriers of World Trade

It is no disgrace to be a tramp freighter. Hundreds of them puff busily about the oceans, carrying a large share of the world's commercial goods. You can see them in any port, loading or unloading every kind of cargo. Some are neat and trim, like the Dutch freighter loading lumber. Some are

rusty and dirty and battered. Some have steam engines. Some have Diesel engines. All of them go wherever business takes them.

Liners have a very different kind of job. Passenger liners operate on a regular schedule, as trains and busses do. But even the most luxurious passenger liners carry freight. The ship in the picture on page 315 is a passenger liner. As the passengers walk up the gangplank to the deck high above, few of them even look down to see the cargo going into the hold of the ship. The cargo will be stowed away below the water line.

Passenger liners have government contracts to carry mail. They carry express packages and bags and crates and boxes filled with many kinds of goods. The liner captain does not have to find a cargo. Shippers make arrangements with the people who work in the offices of the line.

There are freight lines, too. The ships have regular routes, but they do not keep so closely to a schedule as the passenger ships do. Other ships belong to companies with products of their own to be transported. On pages 315–316, for example, you read about ships that carry bananas. Oil companies own tankers to carry petroleum and its products. Some lumber companies own ships specially fitted to carry lumber.

From sails to engines. When you looked at sea trade last, it was just beginning to reach around the world. Ships were still being blown about the oceans before the prevailing winds. They were dodging in and out of ocean currents according to whether the currents would help or hinder them. Although ship design was greatly improved, sailing ships could not be freed entirely from the control of the wind. As late as 1849, ships sailing from New York to California often swung so far to the east that

passengers sighted the coast of Africa. In the same year, a ship waited five days outside the Golden Gate for a wind that would take it into the harbor of San Francisco.

A few steamships were already in use on the Atlantic. Before long there were passenger steamships on the Pacific, too; but for many years longer, most freighters were sailing ships. Fast-sailing clipper ships did not reach their finest development until after steamships were already in use. Perhaps no more beautiful means of transportation ever existed than a clipper under full sail, but there are no large sailing ships on the oceans now. Modern world trade cannot wait for the wind.

Cargo planes. When we think of world trade, we usually think of ships. Really, though, world trade and ships do not go together like bread and butter. World trade is the whole system of exchanging goods between widely separated regions, especially between different countries. The commodities of world trade move by land as well as by sea. In very recent times, some of them also move by air.

On page 47 you read about Norwegian planes that carry fresh fish from Norway to the large cities of central Europe. Planes

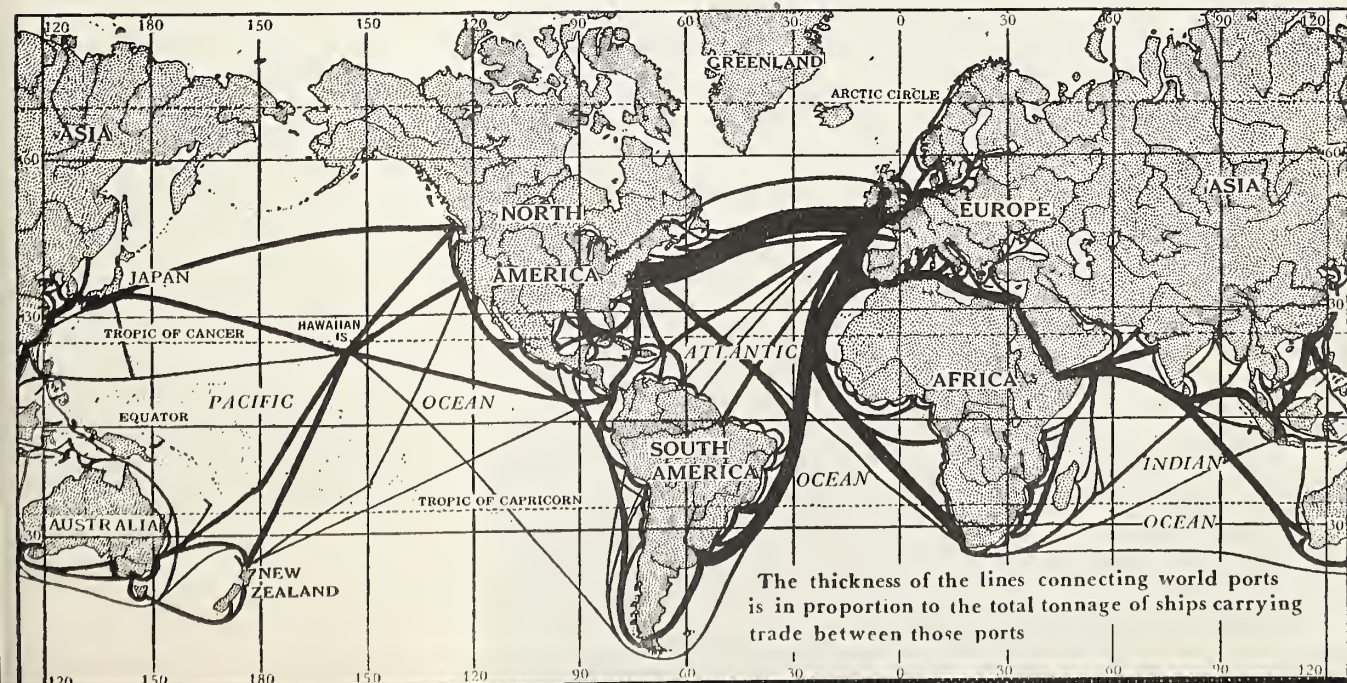
carry winter vegetables from southern Europe to northern Europe. As long ago as the 1930's, planes were carrying pieces of heavy machinery from the United States to mining regions in the Andes. Small packages can be sent by air mail or air express. All this carrying is part of world trade. So far, it is only a small part, but it is growing all the time. How much it will grow no one knows as yet.

World Trade Routes

Steam freight ships from the world pattern of ocean currents and prevailing winds. It is possible for ships today to go wherever there is open sea. Each captain could choose his own course, but ships follow certain definite routes so generally that most writers use the term sea lanes for these routes. Even airplanes crossing the oceans usually follow the same routes. Shipwrecked sailors in lifeboats and flyers forced down in the water feel confident of rescue if they are on the regular sea lanes.

The shape of the earth, the distribution of land and water areas, and the location of seaports and products are the principal reasons why ships and planes follow definite routes. The map shows the great world ocean trade routes. The width of the lines

The great ocean trade routes of the world.



does not indicate the width of the sea lanes. The width of the lines indicates the comparative quantity of goods carried over the various routes. Naturally, ships do not follow one another like automobiles on a highway. On any route they may swing a good many miles to right or left.

As a rule, ships follow the shortest sea routes. Routes follow the coast lines partly because ships must go around the continents and partly because there is much coastwise trade from port to port. There is heavy traffic on the Mediterranean Sea-Suez Canal-Red Sea route because that is the shortest road between western Europe and southern and eastern Asia. Routes cross at the Panama Canal for reasons you can see.

The shape of the earth was mentioned above as a reason for the course followed by many routes. No doubt you have guessed the connection. If chalk can be used on your classroom globe, mark the routes on it. At least stretch a string from port to port for the long routes across the open ocean. You find that they are almost great-circle routes. There are reasons why they do not all follow great circles exactly. In the North Atlantic, for example, ships do not go as far north as a perfect great-circle route would take them.

We often think that sea trade means going long distances, but these cattle are going only from one Hawaiian port to another.

Kaufmann & Fabry Company



The North Atlantic is foggy and stormy; but the greatest danger is from icebergs carried southward by the ocean currents.

Cargoes and seaports. World trade is a very complex subject. There is no easy, simple explanation why some of the routes on the map are more important than others. The whole story cannot be told here. Part of it belongs to subjects that you will not study until later. The following paragraphs give you just a few examples of the importance of geography in world trade. The geographic relationships are basic. Without products, land transportation routes, and seaports, there could be no large-scale world trade. The habits and customs of the people, their culture, their level of technology, their standard of living, and the laws they make all modify the relationships between the earth and the people who live on it.

For sea trade there must be seaports, and a seaport must have a harbor. The importance of good harbors is often exaggerated, however. People do not carry on world trade just because they have a good harbor, and they are not usually kept from world trade by lack of a harbor. A few examples will show what that statement means. Look

at the coast of southern Alaska. There are many fine harbors along the coast, but no great seaport. Then follow the coast southward to Los Angeles. The natural harbor was very poor, but Los Angeles is one of the world's great seaports. The people made the harbor at great expense by dredging channels and building breakwaters. Some seaports on the west coast of South America had no real harbors until recently. Ships anchored offshore with almost no shelter. Goods were carried back and forth in small boats.

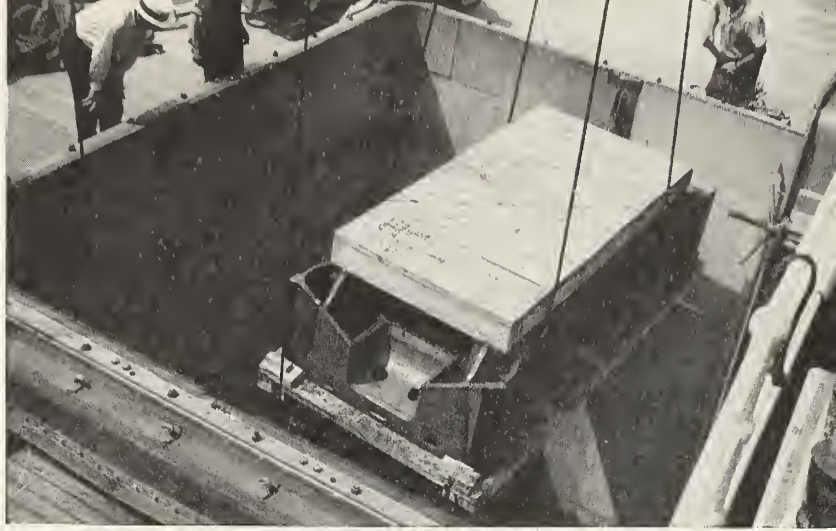
Liverpool, England, is one of the world's greatest seaports, but

the water in the harbor is not deep enough for modern ships except at high tide. The people have built costly sea walls and locks to trap the water at high tide, so that ships at the wharves will not rest on the bottom when the tide goes out. There are better harbors across the Irish Sea in Ireland and to the north in Scotland, but the great world trade routes lead to Liverpool. There are many places with good harbors that have not become great seaports. There are also many important seaports that do not have good natural harbors.

Land transportation routes to the coast are more important than the quality of the harbors. You saw how medieval trade followed natural highways. The same routes are important today, although modern means of transportation have added other routes. Railways and modern highways can be built over routes that medieval means of transportation could not easily follow, but the easier routes are still the most traveled.

Turn back to the map on page 301 and find the huge circle that stands for goods shipped through New York. It is now the world's busiest seaport, but throughout colonial times Boston was a more important port. The other Atlantic ports were also rivals. New York did not begin to outgrow them notably until after the Erie Canal was opened in 1825. You have read many times about the importance of the Mohawk Valley route, but all the eastern seaports are at the ends of possible routes. Look at the early railways on the 1840 map, page 376. After the invention of steam locomotives, the people of every seaport tried as soon as possible to build a railroad to the interior.

On the coast of the Gulf of Mexico, there were settlements at Pensacola and Mobile before there was a settlement at New Orleans. New Orleans outgrew them in population and in trade because it was on the Mississippi



Philip Gendreau

Machinery, an important export product from industrial regions, is being lowered into the hold of a ship.

River, the greatest natural highway to the interior of the continent.

By comparing maps, you can see that the busiest trade routes connect regions of dense population. The volume of trade is partly a cause of the population density, partly a result of it. Through ancient and medieval times, world population was very sparse. It is possible that there were already spots of dense population in eastern Asia, but Europe did not show even a beginning of its present population pattern.

Starting with the great period of exploration, the population of the world grew enormously. You are accustomed to thinking of most regions of dense population as industrial regions. They are industrial regions today, but their growth began with trade, not industry. The industries themselves are partly a result of trade. Every industrialized country in the world depends partly upon world trade for its raw materials and markets. The Soviet Union is the most nearly self-sufficient, but even the Russian people must buy some of their raw materials outside their own country. They have also been large importers of machinery.

Many people believe that world trade depends principally upon differences in levels of technology. They think that it is largely an exchange of manufactured products from



Pan American Airways System

Watching a seaplane take off from the waters of West Africa on the second lap of a trip from Europe to America.

industrialized countries for raw materials from countries that are not industrialized. But look again at the trade-route map on page 323. Which line indicates the greatest volume of trade? This line is the North Atlantic route, between the most highly industrialized region of North America and industrial western Europe. In culture and technology, these two areas are more alike than any other two large regions in the world. The trade is mainly in food and manufactured goods between peoples with the same wants and similar standards of living.

The structure of world trade. World trade is really trade—the exchange of goods. There is not enough money in the world to pay for even a small part of the goods that

enter into world trade. A country that exports goods must import goods. There is no other way of getting paid for its exports.

The trade does not necessarily have to be a direct exchange. For example, the plane in the picture is leaving West Africa for America. From this part of West Africa valuable waxes are exported, such as you read about on pages 139–140. The plane may be carrying some of the waxes for an American manufacturer. The man in the picture may have been the one who collected the wax and sold it to a trader. With the money, he may have bought cotton material for his clothing. If so, he did not trade the wax for American cotton cloth. The cloth was woven in France, but the wax is going to America.

How can wax sold in America pay for cloth bought in France? It can pay for it because the French people buy goods in America. The exchange is made by means of banks and credit.

The same people do not do the buying and selling; but to make it very simple, we can imagine a direct trade among individuals. Suppose the owner of a French cotton mill likes American music. He wants to buy American phonograph records. The American manufacturer of records does not want French cotton cloth. Plenty of cotton cloth is made in America. He does need wax, because it is a raw material for his records. The West African has the wax, and he wants several pieces of French cloth. He sends some of the wax to the American record manufacturer. The American record manufacturer sends records to the owner of the French cotton mill. The owner of the French cotton mill sends cotton to the West African. And so each one gets what he wants, and each one is paid.

A WORKSHOP ON TRADE

Just to get an idea of what trading is like, you might try a little trading with other members of your class. Of course you cannot trade clothes or textbooks or anything else of real value. Select something that is not worth much money or something that you have made. Try to find a classmate who will give you something in exchange that you would rather have.

Your Community as a Laboratory

Do you use any articles at home that have never been bought and sold? Gifts do not count, for someone else bought them. Homemade bread or ice cream or clothing does not count unless the raw materials, too, were produced at home. If you live in town, garden vegetables and fruit are the only home-produced articles anyone is likely to have. If you live in the country, you may have eggs, meat, and dairy products produced at home. For most of you, whether you live in country or town, nearly everything you have has come to you through trade.

MERCHANTS OF YOUR COMMUNITY

Do you know any storekeepers? If you do, ask them to tell you about their businesses. What do they sell? About how many different items do they carry in stock? How do they know when to order more? How do they get new stock? Where does it come from, and how is it delivered? Any storekeeper can tell you more about retail trading than this book has had space to tell you.

Look for as many different kinds of retail business as you can find in your community. Some of your local merchants sell many kinds of goods; some, only one or two. Learn what each kind of store is called and where to go for anything you wish to buy.

TRADING AREAS

Your community is part of a trading area. If you live in a large city, it may be the wholesale center for the surrounding area. If so, find out something about the wholesale businesses of your city. What commodities do they handle? Where do they get them?

Where do they sell them? What kind of transportation do they use for shipping them?

Every community has a business district, in which most of the stores are located. The people of the town and surrounding country do their buying in these stores.

For everyday purchases, such as canned goods, soap, and tooth paste, people usually buy in the nearest store. This may be a neighborhood store in the city or a village store in the country. Such things come in a few well-known brands. They are sold in almost every community, and they are exactly the same wherever you buy them. In such things as clothes and furniture, people often want a wider selection than they can find in the local stores. In a city and its suburbs, they may go to the main business district. From small towns and country, many people go to the larger cities for their more important shopping. Others send for goods from the city by mail.

What are the buying habits in your own community? Start with your own family and make your study as complete as possible.

GOODS GO TO MARKET

Ever since you began using this book, you have been studying the products of your community. You know them well by now. This is the time to find out how they go to market—where they are sent and how.

Test Your Skill and Knowledge

In this book no chapter is complete within itself. Understandings and knowledge you gained in earlier chapters are used again and again in later chapters. Now you are almost at the end of the book. You are studying trade, an industry that ties together all that you have learned about people, natural resources, products, power, manufacturing, and transportation.

In working out the following activities, you will need to use information and understandings from other chapters as well as from this one. You will also need to use maps, graphs, tables, and the Index. You will not be told where to look. How to use the materials in your textbook is part of what you should have learned.

WHAT DO THEY TRADE?

List five cities in the United States that have more workers in trade than in any other group except the service industries. Then answer the following questions:

1. Your list should have three seaports on it. Through two of those seaports many cans of fish, fruit, and vegetables are shipped. Which two?

2. Tankers come into two of the ports to take on cargoes of oil. Which two?

3. Through which of the ports is the most lumber shipped out?

4. What city on your list of five has the highest percentage of its workers in trade? Is it a seaport? The city is a collecting and processing center for two very important farm commodities. What are they?

5. One city on your list is the wholesale trading center for a fairly large area, but it is not a collecting or shipping point for any special commodities. Which city is it?

TO PROVE OR DISPROVE

In this book find proof that some of the five statements below are true and that others are false.

1. On the whole, countries that have a high percentage of workers in manufacturing also have a high percentage in trade.

2. In general, the more densely populated a country is, the higher the percentage of workers in trade.

3. The most densely populated sections of the United States have the highest percentage of workers in trade.

4. The greatest volume of world commerce is carried on between regions that lie in the middle latitudes.

5. The densely populated industrial region of western Europe is the center of world trade routes.

PROBLEMS TO SOLVE

The following activities are problems. In answering them, you will have to think, as well as remember what you have learned. This book does not give you all the complete answers, but it has given you all the information you will need for thinking out your own answers.

1. Long after the Suez Canal was dug, sailing ships carried huge quantities of wheat from Australia to England after each harvest. The grain ships made faster time by taking the longer route eastward around South America. Why?

2. It would be possible for a large cargo plane to reach almost any spot on earth nonstop. Actually such planes stop to refuel several times on a long flight. Why?

3. Why is it impossible for ships on the Pacific to follow a perfect great-circle route from Seattle to Shanghai?

4. The longest railway in the world is the one across the Soviet Union from Moscow to Vladivostok. The Russian engineers who planned the road could have shortened the distance greatly by laying out the road along a great-circle route. Why did they not do so?

5. Phoenicians and other ancient traders made long and dangerous sea voyages to get tin. It was probably the most important commodity in world trade. It is one of the most important commodities in world trade today. How to get enough tin was one of the most serious problems of the United States in World War II. During the Middle Ages, and down to the nineteenth century, only small quantities were used. Why was tin of great importance in ancient times and in recent times, but not during the two thousand years or more that lay between?

ADDITIONAL INFORMATION

Look over the materials you have collected for earlier workshops. You will probably find information about trade in booklets on products and transportation.

From your government you can get booklets on world trade and the marketing of products. Some of the government publications have interesting articles on goods that enter into world trade and on trade with other countries. Other publications are filled with statistics from which you can make graphs.

Your local newspapers will give you a good start on the study of stores in your community. Read the advertisements to find out what the retail stores have for sale.

The Chamber of Commerce of your town may have materials you can use.

To get an idea of all the hundreds of different articles people buy, study the catalog of one of the large mail-order companies.



All the World's Workers

WIDENED HORIZONS

At the beginning of this book, your attention was called to the work going on around you. Do you understand this work better now than you did when you began to read on page 3? As you watch people at work, do you see things that you did not notice before you began to study this working world?

You can see more from a hilltop than you can see from the bottom of a valley. Your horizon is wider. The heading above, "Widened Horizons," is a figure of speech. It means that each new understanding you have gained is like one more step up a steep hill. Perhaps the going has been hard at times. Some of you have been able to climb a little higher than others; but if you have learned anything at all, you can see and understand more of the world around you.

From your new viewpoint, you see relationships you could not see before you climbed

the imaginary hill. You see how the details fit together in larger patterns. You see how each person's job fits into the common task of all the world's workers, which is to supply all the people in the world with the things they need for comfortable, happy living. From your hilltop you see farmers at work in cotton fields. You see cotton gins, textile mills, a coal mine, a power house, men repairing electric power lines, trains and trucks, a clothing factory, and a boy buying a new shirt in a store. If the cotton farmers stopped raising cotton, if the men at the gin stopped cleaning cotton, if the textile-mill workers left their machines, if the coal miners stopped mining coal, if the workers at the power house shut off the generators, if the electricians did not keep the power lines repaired, if the truck drivers and train crews did not keep transportation

moving, if the garment workers did not cut and sew, if the storekeeper did not keep his shelves stocked with goods—if any of these people stopped doing their work, the boy in the store would have much more difficulty in getting a new shirt.

This book has guided your study of one industry after another. It has explained the techniques by which the natural resources of the earth are used to produce goods that people need. It has explained how these goods are collected from the producers and

distributed to the consumers. Details have been explained so that you can understand the work done by many individual workers and the importance of each worker's job. The details are interesting to anyone who likes to know about the world around him, but it is the fitting together that really counts. You may have forgotten many details. No one could remember them all. The forgetting of details is not important if you remember that we all work together for the same final purpose.

WE ALL WORK TOGETHER

As you studied the world's work, you learned that methods and techniques have changed. You found that one industry could not progress alone. No one technique can advance very far beyond the whole level of technology in a given culture. A new invention depends upon earlier inventions and leads to later ones. New techniques developed in one place spread over larger and larger areas of the earth. Sometimes technology has advanced very slowly or not at all. During the past century and a half, changes have come faster than at any other time in the history of the world. The speed of change has seemed to increase all the time since the beginning of the Industrial Revolution. During the 1940's, many new inventions and discoveries came into use because of the urgent needs resulting from World War II.

Changes have come so fast that our world is out of balance. Inventions in some industries have not kept up with inventions in others. We know that new techniques, new materials, new scientific knowledge will bring about further changes in the world's work and in our daily living. We do not yet know what these changes will be. But we do know that, whatever they are, they will affect all of us.

The world is full of unsolved problems. One of the most serious of these problems is

a very old one, but no one as yet has been able to find the right answer. This is the problem: How can all the people in the world find a way to make a good living? This whole book has really been about the attempts people have made to solve this problem. Even with all the progress in technology, the problem is still not solved.

More Goods for More People

People have always had to get a living from the earth. This book has told you how people have tried to solve their basic problem of getting a living in the past and how they are solving it today. You have read about a number of different cultures. Differences in culture center around differences in ways of getting a living.

Scientists think there must have been a time when people had no culture at all—when they just ate what they found, using no tools or weapons or techniques for making the products of the earth more useful. We have no way of knowing about such people. The simplest culture we know is the hunting, fishing, and collecting culture of the Old Stone Age. It is very simple, but it is a culture. People of the Old Stone Age had fire to keep them warm and cook their food. They had tools and weapons of stone. They wore clothes made of animal skins, and they

had homes. We know that some of them lived in caves, and others must have built some kind of shelter for themselves. With fire, clothing, and the ability to shelter themselves from the weather, people could live in any region that had resources to support them. With those simple techniques they pioneered the earth. Even the Eskimos of the Arctic region were able to live with Old Stone Age techniques.

Old Stone Age culture was an answer to the problem of getting a living from the earth, but it was not a very good answer. With Old Stone Age techniques the earth would support only a few people. At best, standards of living were very low.

From the Old Stone Age to the present time, the earth has had about the same resources. Then it supported only a very few people with a very low standard of living. Some scientists believe that there may have been only a few thousand people on the whole earth. The same resources now support thousands of times as many people. All but a very few of them have a much higher standard of living than the people of long ago. The resources are the same, but the methods of using them have changed.

From time to time a basic invention has brought a whole new culture into the world. People have discovered more and more of the earth's resources and have invented ways of making better and better use of them. Improvements in technology have been attempts to find new answers to the old problem of making the earth produce more goods for more people. We are still trying to find methods that will produce even more goods.

Culture and standard of living. Food is the most important thing in the world because people cannot live without it. In order to get more food, people have worked hard to make the soil more productive. The techniques used to make the soil more productive are called farming. Perhaps you never heard that definition of farming before, but it is a true one.



United Service to China, Inc.

The problem of a good living for all the people in the world is still not solved. In a year of poor crops, Chinese farmers gather weeds to keep them alive until the next harvest.

You have read how farming began and how it provided more food for more people. Even the simplest farming does that. As the techniques of farming spread over the earth, the population increased. The invention of farm tools, the use of animals, irrigation, the domestication of more plants, improvements in plant varieties—all these made the earth more productive.

To the end of the Middle Ages most people in the world were farmers. There were traders and craftsmen and a few other specialized workers, but they made up only a small fraction of the world's population. Most people were still peasant subsistence farmers. They grew crops and raised animals, not for sale, but for their own use. As you have read, nearly everything was home-



Rathenau from Pic

A market in Java. Peasant farmers have brought the tiny surpluses they can spare from their crops.

made. Each family depended almost entirely upon itself.

Until a few hundred years ago the lands of peasant farmers had the most advanced cultures in the world. Lands of peasant farmers can produce a very fine culture. When all goes well and the population is not too dense, everyone can have enough to eat and enough clothes to keep him warm. A few people can have much more than that. From very early times peasant farmers were able to produce a small surplus. That is, they produced a little more than was necessary to keep them alive. When craftsmen began to specialize, the peasant farmers used a little of their surplus to buy a few products. When traders brought goods from a distance, peasant farmers began to buy from them.

Peasant farmers had so little to spare that they were not willing to trade many products for other goods. What they were willing to trade would not support many people in

other industries. Their governments usually forced them to give up far more as taxes and rent than they would spend willingly. When people live in groups, they must have some kind of government. It is much harder to invent a good government than to invent better farming techniques. For a long time a government meant a ruler who told other people what to do. At first, probably, the rulers were headmen of villages and were not very different from other people. Gradually they got more power. The ruler of one village conquered neighboring villages and became king of a fairly large area. He needed officials to help him. The king and his officials became a ruling class, or nobility. They thought of themselves and their families as superior to other people. Usually they owned all land. They did not work on the land themselves. The peasant farmers had to give the rulers a share of their crops. The peasant farmer paid for the right to use

the land, but the payment was not exactly rent for the land. It was more like taxes for the support of the rulers.

It is difficult for us to understand how those people felt about their rulers and their government. Our ideas are so different that it is hard to make comparisons. We pay taxes to support the government, and our government officers get regular salaries no larger than the salaries of many other people. In earlier times all the taxes belonged to the rulers. They had to pay the expenses of the government, but they collected far more than they needed to spend for governing the country. Thus the ruling classes became very wealthy. They used their wealth to put up fine buildings. They hired artists and craftsmen to work for them.

In ancient Egypt, India, and China, in the lands of the Incas in South America and the Aztecs in Mexico, the fine civilization belonged to the nobility. As farming techniques improved, the peasant farmers reached higher standards of living, but they could never hope for a share in the luxuries of their ruling classes. At times, as in ancient Greece and Rome, larger numbers of people were able to reach the higher levels, but never all the people. The level of technology was not high enough to provide the best for all the people.

We marvel at the beautiful things produced by people of earlier cultures. We admire their art and literature, their fine thinking, their good manners, their gracious living. It is right that we should admire these things; but we should remember, too, that only a few people were able to enjoy them. The vast majority of people had barely enough of the simplest and most monotonous food. They had poor clothes, houses that we would not use to shelter farm animals, and no luxuries at all. Without the few who had the wealth, civilization would probably not have advanced far; but all its early advances were made at the expense of the peasant farmers who were forced to give up a large share of the little

they had. They could not hope to have more or expect that their children would have more.

A denser population. For hundreds of years the population of the earth increased slowly. The world was not crowded, except in a few small regions. There was unused land to be brought under cultivation, and farming techniques improved somewhat. Thus the slow population growth could be taken care of without much difficulty.

Then for some reason the world's population began to increase very rapidly. Scientists have tried to explain this rapid increase, but none of their explanations are very satisfactory, even to themselves. Five hundred years ago there was no area of dense population in western Europe. In all the Americas there were only a few million Indians. Even in eastern Asia, population was probably far less dense than now.

In the past few hundred years the population of the earth has grown so fast that food has become a serious problem. In general, there have been two answers to the problem of feeding the growing population. These might be called the answers of the East and West. The East is used to mean eastern Asia—India, Pakistan, China, Korea, Manchuria, Japan, southeastern Asia, and Indonesia. It was the East to the people of western Europe. The West means western Europe and the Americas. Used in that way, the terms East and West are not exactly reasonable, but they have been used for such a long time that they are not likely to change. You might as well learn them, for you will find them in newspapers, magazines, and books.

Almost always the East has found one answer to a problem and the West has found another. The cultures are so different that we usually speak of them as two different civilizations. Eastern cultures have one answer to the problem of making the earth more productive. Most eastern farmers have kept the old pattern of peasant farming



Courtesy Netherlands Information Bureau

Rice harvest in the East.

and have put more and more work on the land. Farms have been divided among the sons of a family for generation after generation. The share of each has become very small, but he must still grow food for his family on the land he has. He works harder and harder, and all his family work harder and harder to make a living from the land. They waste nothing. Every square foot of land is used. Every scrap of waste animal and vegetable material is used as fertilizer. Where the climate permits, crop follows crop on the same land. According to their technological level, their skill, and their environment, the people of the East cultivate their land as intensively as they can. They do produce large quantities of food in proportion to the land they have.

The region we call the East is vast. It has hundreds of millions of people. They belong to different nationalities and even different races. Some are at a high level of technology and culture. Others are at a low

level. They all have essentially the same answer, though, to the problem of food for more people. They divide the land into smaller and smaller pieces, and each family works harder to make a living from its little piece. Most of the people remain farmers. The graph for India, page 389, is typical.

The answer of the West is as different as can be. It has been the answer western civilization gives to most problems—science and mechanization. Through scientific, mechanized farming methods, each man's work becomes far more productive. The people of western regions have not had to cut the land smaller and smaller to give each family a farm. Instead, many of them leave the farms and go into other kinds of work. Because of science and mechanization, a small fraction of the population can produce food for everyone. The rest of the people can spend their time making goods that peasant farmers never have at all. Thus the standard of living is raised. On the



Courtesy International Harvester Company

Rice harvest in the West.

average, an acre of land produces less by western than by eastern methods, but a man's work produces many times as much.

More products for more people has been the world's greatest problem. You have seen two attempts to answer that problem—the answer of the East and the answer of the West. The answer of the West has proved to be the better answer to that particular problem. Science and mechanization do produce more goods for more people, but they create other problems. One of the greatest of these is the problem of working together.

Working Together

In communities of peasant farmers such as the Chinese villages described on pages 74–77, each family works for itself, and all families do about the same things. In the spring everyone is preparing the soil and planting the seeds. During the summer

everyone is cultivating the crops and harvesting those that are ready. These people have a feeling of working together because they are doing the same things at the same time. The same things are important to all of them. Bad weather at harvest hurts them all; good weather at harvest makes everyone happy. When crops are good, everyone eats well; when crops are poor, everyone is hungry. Each person knows what the neighbors are doing and is interested. He understands their work because it is like his own. Children learn about the work of their community because they share in it. They know what they will be doing when they grow up, and they learn how to do it by helping. The boys probably know just which piece of the family farm each one will have when his father dies.

Such a pattern of living has real values that western ways of living have lost. Each person has a strong sense of belonging to his family and his community. Even though



Haddie from Frederic Lewis

A Chinese family stops work for lunch in the fields. Peasant subsistence farmers can be happy when all goes well, even though their standard of living is low.

he knows that he may be hungry sometimes, he feels secure. He knows just what is expected of him. He is expected to do well what his ancestors did, in the way they did it. If he tries to change the rules, the older members of his family will not approve.

The people of a peasant-farmer community are conservatives in both the good and the bad meanings of the term. They waste nothing that can be used. They work very hard to keep up the fertility of the soil year after year. All that is good. But they are conservative also in the sense that they are slow to accept new ideas and new methods of working. What was good enough for grandfather should be good enough for grandson. Children are taught to be satisfied with what they have rather than to want something better. Such ideas are what people mean by the "unchanging East."

The people of such a community seem to be working together; but in fact each family is working by itself. The work of one person depends very little upon the work of anyone outside his own family. If all but one family moved out of a village, that one remaining family would get along almost as well as it did before.

The people who live in regions of western culture have far less feeling that they are working together for the same purposes. Neighbors do not usually do the same kind of work. Their day-to-day needs and purposes are different. For example, imagine you live in a community in the northern part of the winter-wheat belt. It is winter, and a heavy snow falls. The wheat farmers are pleased. Snow will keep the wheat plants from freezing. When it melts in the early spring, it will supply moisture just when the wheat needs it most. But here in the same neighborhood lives a cattle rancher. He does not grow

wheat, and he does not like the snow. The snow covers his pastures. It means that his cattle cannot graze and must be given other, more expensive, feed.

In the nearest town, the manager of the elevator likes the snow. It will help the wheat farmers to have a big crop, and his business will be good. The elevator manager is happy, but his next-door neighbor is very unhappy. The neighbor owns a fleet of trucks. His trucks may not be able to operate for days, until the snow has been cleared off the highways.

That is a very simple illustration of the different needs of people who are neighbors within the same community. Suppose the elevator manager and the trucker are both out shoveling snow from the sidewalk. The elevator manager is happy and shouts to his neighbor, "Isn't this a wonderful snow? It means good business for me."

The trucker is angry. He shouts back, "You'd like to see my business ruined, would you?" And probably they do not speak the next time they meet.

The elevator man does not want his neighbor's business to be ruined, but he cannot help being pleased that prospects are good

for his own business. The two men cannot be really good neighbors until each one understands the problems and viewpoint of the other. Since this is a wheat-growing region, the snow is really good for the community as a whole. It will help the wheat farmers to be more prosperous. It will help the businessmen in the town, because the farmers will have more money to buy their goods. It will even help the trucker in the long run. Bringing goods to the stores is an important part of his business.

The next time it rains on the day you would like to have a picnic, you will probably feel unhappy. But stop to think about the people who are pleased by the rain. That will be a good exercise in learning to see your neighbor's viewpoint. Our ways of living are so complex that not even the weather can please everyone at once. In the village of peasant farmers, the same weather is good weather or bad weather for everyone.

But there is another side to that picture, too. The wheat farmer, the cattle rancher, the elevator manager, and the trucker, all have a far higher standard of living than anyone in the village of peasant farmers can ever hope to have. They have the higher standard of living because of the very specialization and division of labor that make it hard for them to understand one another's problems.

When the machinery breaks down.

There is more to working together than understanding our neighbor's problems. Our kind of culture is like a machine. If one part breaks down, the whole machine breaks down. Here is a simple example. A few years ago unusually heavy snow fell in the eastern part of the United States. Perhaps farmers who grow wheat were pleased, but the eastern United States is not a wheat-growing region. The snow was a misfortune for millions of people, some of them hundreds of miles away. It blocked transportation on eastern highways and rail-

roads for days. Food supplies ran low. Goods piled up because they could not be moved. Perishable goods spoiled. Worst of all, coal trains could not be moved out of the mining regions of West Virginia and Pennsylvania. People ran out of coal for their homes. Factories shut down, and many steam power plants could produce only enough power for the most urgent needs. Even in areas not covered by the great snow, railroads had to cut down their services because they could not get coal for their coal-burning locomotives. In the steel mills along the Great Lakes, the fires went out in many furnaces. Other industries depended upon the steel those furnaces should have made, and they, too, were handicapped.

When heavy snow falls on a village of peasant farmers, each family shovels itself out and life goes on as before. Perhaps the people are a little uncomfortable, but the results are not serious. There is the usual food stored away. There is the usual fuel. Factories and power houses do not shut down. Perishable foods do not spoil.

Factories and power houses do not shut down because there are none. Perishable foods do not spoil because the people do not have food brought from a distance. Fuel is

Can you imagine how trains would pile up if railroad men did not work together according to a plan? The man in the picture is recording the numbers of freight cars. Plans are based on such records.

Courtesy Norfolk & Western Railway



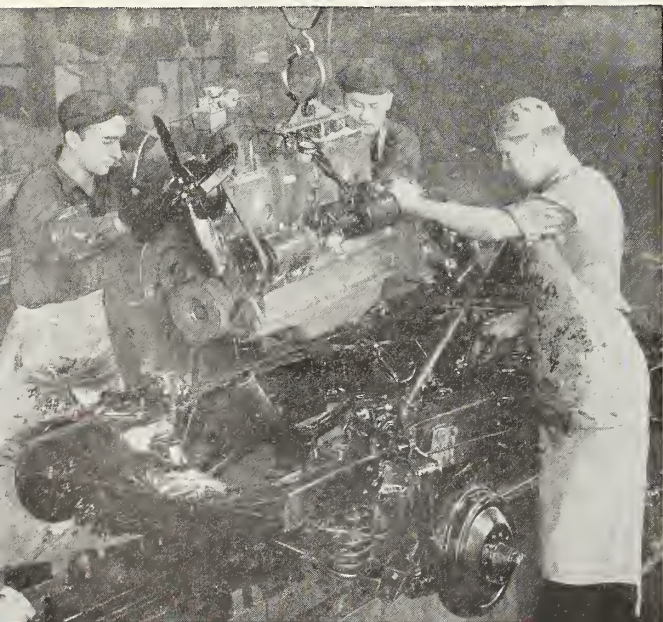
as plentiful as ever, but at best it is nothing more than twists of straw and scraps of wood. Peasant farmers are no worse off when other people are unable to do their work, because their living does not depend upon the work of other people. Our living does depend upon the work of other people. When the workers in any industry fail to get their work done, everyone suffers.

Growing interdependence. Most of the things you have been reading can be summed up in one word—*interdependence*. That is a long word, but it becomes clear when you take it apart. You know what dependence means. *Inter* means between or among. When we say that people are interdependent, we mean that they depend upon one another.

As you have seen, modern industry is impossible without interdependence among industries and among workers. Think for a moment about the automobile assembly line described on pages 258–259. If each worker had to go to a stockroom and get more materials for himself, the assembly line could move only a few minutes at a time. The worker does not have to get his own materials, however. Someone brings them.

Assembling an automobile. The men in the center are lowering an engine into place. The engine parts were made and assembled by other workmen. So were the many parts already attached to the automobile frame.

Philip Gendreau



Suppose it is the workman's job to put a clock in each instrument panel. Someone brings the clocks to him from the stockroom. Before that, someone put a large supply of clocks in the stockroom, to be brought out as needed. Before that, workmen, probably in another factory, made the clocks. In that factory also there was division of labor. Different workers made the separate pieces of the clocks, and other workers put them together. Even this factory was not the beginning. Ready-made sheets of metal, sheets of glass, screws, nuts and bolts, paint, lubricating oil, and cartons for packing, all came from other factories.

These factories got their raw materials from still other producers. In the case of the clocks, most of those first producers would be miners. Other materials used in automobiles you could trace back to farmers, forest workers, or even fishermen. Yes, the fishermen really belong there. Do you remember the fish-scale paint mentioned on page 44?

A handicraft worker makes a whole article with a few simple tools. Workers in modern industry cannot do their work without many specialized tools and machines. The tools and machines make the work of each man much more productive, but they also make him much more dependent upon the work of other people. As you have read earlier, mechanization makes specialization and division of labor absolutely necessary. Most machines do just one job, and so the man who operates a machine does just one job.

This coöperation in the making of a product is only a small part of the story of interdependence in our industrialized culture. Most workers depend upon other workers to keep their tools and machines in order. A sawmill has men who do nothing but sharpen saws. In factories, mines, and quarries there are tool sharpeners. Thus each person's work depends upon the work of many other people who have nothing to do directly with the making of the product. The examples are taken from manufacturing, but

there is the same kind of interdependence in all other industries. As a rule, the more highly mechanized the industry, the greater the interdependence among the workers.

Among modern workers farmers are probably the most independent. Do you see the difference between independence and interdependence? Generally the work on a farm is still done by one family. The farmer has to plan and carry out many different jobs, but he is by no means as independent as the peasant farmer in a Chinese village. He is far less independent than the farmers of earlier days in America. In the chapter on farming you read about farms of a century or so ago. On those farms many crops were grown and prepared for use. Now very few farmers process their crops on the farm. They depend upon other people to do that. There are also many more specialized farms now than there were a hundred years ago.

Even on so-called general farms there is much more specialization now. Modern farmers use great quantities of capital goods in the form of machines and equipment. There is specialized equipment for almost every farm job. No one farmer can own enough of this equipment to raise all the crops that will grow in his region. Instead, he specializes in a few products. He knows that he will be more prosperous if he does not specialize too narrowly; but, if he is a good farmer, he plans his work so that he will get the best use from his equipment.

For example, think of a corn-belt farmer who buys a corn picker. With the corn picker he can save himself much time and work. He can make more profit from his corn crop because he does not need to spend so much of his time in harvesting it. But the first thing he must do with that extra profit is pay for the corn picker. His profit will never pay back the cost of the machine if he raises only an acre or two of corn. He pays for the picker and gets a profit for himself only by raising more corn than he could raise without the machine. Or, if he already uses much of his farm land for corn, he

gets the extra profit by saving time on the corn and using the time in some other way. Whichever he does, the time saved must be enough to pay back the cost of the picker.

A few bushels of corn will not do. The farmer must raise a great many bushels. To get more land for corn, he may plow up the vegetable garden, the orchard, the potato patch, and the pasture set aside for the family milk cow. With the corn picker, he finds it more profitable to grow corn and buy vegetables, fruit, and dairy products.

The farmer still does not use all his land for corn. He feeds his corn to hogs, but hogs need other feed, too. He grows the other feed they need. He may even plant a field of tomatoes for the canning factory. But whatever else he does, he must grow enough corn to make the corn picker pay for itself.

Goods and services. You have been reading about interdependence in work—how one person's work in any industry depends upon the work of other people. You have read about another kind of interdependence, too. Most people depend upon others to produce nearly everything they use. In addition to goods, most people depend upon others for a great many services.

Each of the occupation graphs in the Atlas section of this book has a column marked "Service Industries." If you look over the graphs, you will see that the column is long for most industrialized countries, short for most countries that are not industrialized. Workers in the service industries do things for other people. They are teachers, doctors, nurses, ministers, priests, bankers, lawyers, government workers, repairmen, laundry workers, barbers, beauty operators, actors, musicians, baseball players, scientists, architects, decorators, policemen, firemen, and many others.

There are good reasons why industrial countries have more people in the service industries than farming countries have. On

the whole, there is much more specialization and division of labor in industrial countries. Think again about those villages of peasant farmers in China. The people depend almost entirely upon themselves. There is probably a school with one teacher. There may be no doctor or any of the other workers named on page 339. Of course, there is no whole country in the world with no service workers at all.

As you have read over and over, countries with an industrial culture have a higher standard of living than countries in which most people are subsistence farmers. Commercial farmers share in the high standard of living of their regions. In general, people with a high standard of living pay to have many services performed for them. People with a low standard of living do without most of the services. Think, for example, of the workers whose job is protecting the health of other people. A community in the United States has doctors, dentists, and nurses. There are city, county, state, and national health departments.

Or think about education. Where the standard of living is high, there are more schools and better schools. Students are required by law to go to school until they are fourteen to eighteen years of age. Many go to college and stay in school until they are in the twenties. Now most children all over the world have a chance to go to school, but this was not true until recently. Even yet, in countries with lower standards of living, most children leave school before they are as old as you are now. Such countries do not have many teachers.

In countries with a high standard of living most people hire many things done for them, such as laundry, cleaning, painting, and decorating. In their homes they have equipment that they could not repair for themselves even if they tried. They must take it to expert repairmen, who are counted in the service industries. They also have leisure, and they can afford to pay for entertainment in their leisure time.

People in industrial countries need many bankers, lawyers, and experts to be consulted for advice. They need scientists and research workers to keep their industries progressive. On pages 86–87 you read about some of the scientists and experts who help the farmers. People in other industries have unseen helpers of the same kind.

Thus you see that people in industrial countries, with a high standard of living, get more services, as well as more goods, than people in countries with simpler cultures. Because of the many jobs in the service industries, there is still greater division of labor, a wider choice of occupation, and more interdependence.

An interdependent world. As you know, there is a name for the change from handicrafts to mechanized industry. It is called the Industrial Revolution. You have seen how mechanization led to greater and greater division of labor, and therefore to more and more interdependence. You have read how the Industrial Revolution began in England. From there it spread rather quickly to the western part of the continent of Europe and to English-speaking North America. It spread among all the people who were at that time leaders in the development of western culture. It became, in fact, the outstanding characteristic of western culture. When Australia, South Africa, and other regions were settled by Europeans, it spread to those regions also. There it stopped for a long while.

As time passed, however, the mechanized industry of western regions influenced every country in the world. Nearly all countries had at least a few railways and steamships. If you remember what you have read earlier in this book, you know that Europeans and Americans laid out plantations, opened up mines, and drilled oil wells in regions with simpler cultures. Traders sold factory products and bought raw materials.

The people of the Soviet Union have been working hard to industrialize their country

since the early 1920's. In eastern Europe, Asia, South America, and even in tropical Africa there are new factories. With long-range airplanes, radio, and other improvements in transportation and communication, it is impossible for cultures to remain as different as they used to be. People all over the earth are learning that they can have a higher standard of living through the help of science and machines—that they can have more goods to use when their work becomes more productive. It will be many years—perhaps even several lifetimes—before the villages of peasant farmers are all gone; but already the young people of most regions have a little choice of occupation. At least a few of them can leave their villages and find other work.

Some people are sorry to see the world becoming industrialized. The old cultures

and techniques are interesting and picturesque. They have produced much that is fine and beautiful. To many people in these cultures, the old ways of living are the only ones that seem natural and right. You have seen that change to an industrial culture brings new problems. Most serious of all, perhaps, is the problem of working together, of learning to live in a culture that requires people to be interdependent. In an interdependent world, it is no longer possible for each person to live as he pleases, work when he likes, and produce what he wants to produce. He does have better food, better clothes, and more goods of all kinds to use. He also has doctors, dentists, hospitals, schools, a chance to learn more about the world, more time to play, a better chance to live a long life. Which would you choose?

YOUR JOB IN THE WORLD

Now you have seen just a few of the many jobs there are in the world. Have you been thinking about which of those jobs you want when you grow up? Perhaps this book has helped you to choose something that will be really interesting.

Your Opportunities in a Working World

No one has ever counted all the kinds of work there are in the world. This book has mentioned only a very small fraction of them. You have learned a little about each of the main groups of industries, but you have not read about all the possible jobs within these basic industry groups. In each group of industries only a few of the many possible jobs have been described.

The older industries. A woman works for a fishing company, but she has never seen any of the company's products except when she buys them as anyone else might. She is a

stenographer in a branch office of the company, far from the ocean. All day long she takes down dictation in shorthand or types letters and reports. She has nothing to do with actual fish, but she is a worker in the fishing industry. Without her kind of work, the fishing industry could not be carried on.

The branch office has nothing to do with fishing, either. The people in the office are concerned with selling fish, not catching them, but they are workers in the fishing industry. Fish dealers in the trading area of the city can send orders to the office. People in the office make sure that supplies of fish are available and that the orders are filled.

In the same city the fish company has a refrigerated storage warehouse. From the seacoast fish come to the warehouse by refrigerated freight car and truck. In the warehouse workmen store the fish carefully. When orders come from dealers, they pack and ship the fish called for in the orders. Other workers keep the refrigerating machinery working. There are also people to scrub

the floors. There is a nightwatchman to guard the building when the other workers are not there. All these people work in the fishing industry.

The main offices of the company are in a city beside the ocean. There even more workers are busy writing letters and keeping records. There the top executives of the company do their planning and organize the work of the whole company. Several hundred people work in the offices, and none of them ever handles a fish except perhaps to buy one to take home to dinner. They are all workers in the fishing industry.

Near the waterfront the company has a freezing plant. Workers spend their time cleaning fish, filleting them (you learned what that means on page 45), wrapping the fillets in waxed paper, packing them in pasteboard cartons, and putting the cartons through the freezing machines.

In several smaller towns along the coast, the same company has canning factories. There also workers clean and cut up fish. They pack the fish in cans and put the cans through the necessary processes.

Government statistics would count the workers in the processing plants as being in manufacturing, but they are also in the fishing industry. They are a little nearer to the actual fishing than the office workers.

An executive dictates a letter to his secretary. These people are in the fishing business. In any other business their work would look the same, but the knowledge required would be different.

A. Devaney, Inc., N.Y.



At least they handle real fish. But they are still not fishermen.

The company has several executives whose job it is to see that the processing plants are supplied with fish. They are not fishermen. They never go fishing except for fun, just as you might do. It is their job to find fishermen who will catch fish for the company. They sign contracts with the fishermen. The fishermen agree to catch certain kinds of fish. The big company must send out standardized products and just any kind of fish will not do.

At last we come to the real fishermen whose work was described in the chapter on hunting and fishing. Without them the industry could not exist. On the other hand, not many fishermen could make a good living by fishing if there were no one to process and distribute the fish. Let us see what fishing is like with no one to do the other jobs for the fishermen.

It is mid-morning in a town on an island in the Caribbean. From every part of the town women are walking toward the water front. Each woman has a basket on her arm. Each woman glances toward the blue water as she walks. She is watching a fleet of sailboats headed for the shore. By the time the fishing boats come to land, some of the women are already waiting on the sand. They have hurried to get the pick of the catch. The crew of each little fishing boat unloads the product of their morning's work. They were out before dawn with their nets. The fish are of many shapes, sizes, colors, and varieties. All are fresh and shining.

The women select their fish—several small ones or one large one—and pay the fishermen. They take the fish home and cook them for dinner. They do not put any away to cook tomorrow, for they have no refrigerators and the fish would spoil. Tomorrow they will have to go down to the shore again when the fishing fleet comes in. If the fishermen have any fish left over, the fish are wasted. They cannot be kept to sell later.

The fishermen of the Caribbean island have only a local market. Each day they sell the fish needed by the people of their own town. Fishermen who catch fish for the fish company have the whole world for a market. When fish can be processed and kept, none is wasted. Those that cannot be eaten today can be used tomorrow or next week or next year. The people in the fishing industry who do not fish provide the fishermen with a larger market. They also make it possible for people far from the ocean to have fish.

Fishing is one of the less complex industries. On pages 147–148 you read about the number of different jobs in such a simple operation as getting clay from a clay pit.

In all industries there are many workers besides those who actually produce the goods. In farming there are probably fewer than in any other. Farming has never become a large, highly organized industry. On most farms there is little division of labor, even if the farmer has hired workers. Many of you who read this book will be farmers some day. You will be able to choose the kind of farming you will do, in so far as the climate, soil, and surface of your region permit choice, but you must know how to do all the work yourself. You will be able to get help and advice from many people, as you read on pages 86–88; but to be a successful farmer you will need a wider knowledge and a greater variety of skills than most other workers need.

In manufacturing there is a bewildering number of different jobs. There are so many that even a list of all of them would fill many pages of this book. You could make quite a long list just by looking through the manufacturing chapter and noticing all the specialized work mentioned there.

Research creates new occupations. There is a much wider choice of occupations now than there was a hundred years ago. Look at the picture at the bottom of the next page, for example. It does not seem to have much to do with work, except that you know the storm must be destroying

the products of many people's work. Why should that picture be chosen as a symbol of how research creates new occupations? There are several reasons.

Pictures are not a new idea. In the Old Stone Age artists drew remarkably lifelike pictures of animals on the walls of caves in southern Europe. We can still see thousands of pictures that were drawn, painted, or cut in stone by the ancient people of Egypt and southwestern Asia. It was the fashion in ancient Greece to use dishes with scenes painted on them. Drawing and painting were the only methods available for making pictures in early times, however.

Photography is only a little more than a hundred years old. It could not have been invented earlier because scientists did not know enough about physics and chemistry. The process depends upon a chemical reaction. A plate of glass or a sheet of film is coated with a compound of silver and other chemicals. Light enters the camera and an image of the scene in front of the camera is focused on the plate or film. Then a strange thing happens. The plate or film is transparent. When the light passes through it, chemical changes take place. The brighter the light, the greater the change. Therefore light-colored parts of the scene cause more change than darker parts. When the film is taken out of the camera and washed in the right chemicals, the coating that has not been affected by the light washes away. The part that has been affected turns dark. The result is a picture in reverse—a negative. The parts of the scene that were dark appear light in the negative and the parts that were light appear dark. Light is then thrown through the negative onto a sheet of paper that is sensitive to light, just as the original film was. This reverses the picture again, so that the areas of light and dark are the same as they were in the original scene. You have a photographic print on paper. Such a print was the start of the picture of the storm.

Have you ever seen a photograph taken seventy-five to a hundred years ago? Those

old pictures were very stiff and wooden. Nearly all of them were pictures of people. If you study an old photograph very carefully you may be able to see part of an iron brace rising behind the sitter's neck. The photographer had to be sure the sitter did not move even the least little bit. If he did, the picture would be blurred. To get a good picture the light had to fall on the plate in the same place for several minutes.

Scientists worked to make plates more sensitive—to make pictures register in less time. During the War between the States in the early 1860's a photographer took many pictures of battle sites, soldiers, and camps. Nothing like his work had been attempted before, but even he never tried to take pictures of soldiers in action. He chose scenes with little motion, for any object in motion was blurred in the picture.

Now look at the picture of the storm again. Part of the picture is not clear, but that is because spray from the ocean is blowing across the road. The fronds of the palms are streaming in the wind, but each leaflet can be plainly seen. The leaves were blowing in a hundred-mile-an-hour wind, but the action of the camera was so fast that the

motion did not blur the picture. Cameras and film can now catch objects that are moving even faster. Machines in rapid motion appear to be standing still in photographs. It is possible even to take a picture of a bullet leaving the muzzle of a gun.

Down to about 1890 there was no way of printing a photograph by book-printing methods. Artists made drawings based on photographs. Then engravers copied the drawings, cutting the lines into metal plates that could be used for printing. Sometimes the picture was cut into wooden blocks instead of metal.

For use in this book a print of the photograph was photographed again, this time through a plate of glass ruled in two directions with many fine lines. The lines broke the picture up into tiny dots. The dots were transferred by a photographic process to a plate of copper. Then acid ate away the copper between the dots, and the copper plate could be used for printing the picture in your book. You can see the tiny dots if you look closely.

The technological development back of this one picture is only a small sample of the work done with photography. Now thou-

The fine details in this picture were caught by a high-speed camera, in the midst of a terrific hurricane.

Acme Telephoto



sands of people do work that depends upon photography. Millions of people enjoy the results of their work. Think of the motion-picture industry, for example.

To people at the beginning of the nineteenth century any kind of photograph, even the poorest, would have been a scientific marvel. They would scarcely have believed it possible, but people who were young in 1800 lived to have their own photographs taken. To people who lived in the middle of the century a photograph taken out of doors in the darkness and motion of a terrible storm probably seemed impossible. Seventy-five years ago the reproductions of photographs you have seen in this book would have seemed marvelous.

This book cannot tell you all about all the still newer wonders of photography or the many ways it is now used in industry and research. But there is something else about the photograph on the preceding page that people would not have believed possible even fifty years ago.

That picture was sent by telegraph. While the storm, a tropical hurricane, was still going on in Florida, the picture appeared in newspapers thousands of miles away. The picture in your book was made from a print of the photograph actually sent by wire. When the techniques for sending pictures in that way were first invented, the pictures were blurred. Artists painted over the faint outlines until the pictures scarcely looked like photographs at all. It was only a few years ago that pictures were first sent by wire. Improvement has been very rapid.

You will need to study physics before you can understand just how a picture can be sent by wire. A tiny, bright point of light runs rapidly across the photograph. The light rays are then changed into an electric current. A scientist would not say it just that way, but his language would be very hard to understand. The current is modified by the light and shade in the photograph, and it is this current that goes over the wire. At the receiving end, the current is

changed back to a tiny ray of light. Again the light runs rapidly over a sheet of sensitized paper. On the paper it reproduces the original photograph.

Other marvelous things can be done with a telegraph wire. Few telegraph offices now use the old system of dots and dashes. To send a telegram, the operator simply writes the message on a typewriter. At the receiving end another typewriter writes down the message. The current that goes over the wire controls the action of the receiving typewriter. It is also possible to send a number of messages over the same wire at the same time. Currents carrying several messages and pictures could be going over a wire at the same time, and yet each would come out in its proper form.

The picture is a symbol. The techniques used to make it and print it are no more important than thousands of techniques that have come about as a result of growing scientific knowledge, new inventions, and increasing control over the environment. All the new things in the world mean new opportunities for you. They mean that you will have far more choices of occupation than your grandfather had—more, even, than your father had. You have more opportunities, but you also have more responsibility.

Your responsibility. Your first responsibility is to know. On the next page you will see two pictures of scientists at work. The one in the first picture lived in the Middle Ages. He and a few others like him were laying the earliest foundations of modern science. They realized that some very mysterious things happened in the world, things no one understood. For more than a thousand years no one had even been curious about such things. A few ancient Greeks had been curious, but they believed they could find the answers to their questions just by thinking about the world.

Late in the Middle Ages a few people became curious again, and they began to use a new technique. These medieval scientists



The Bettman Archive (from a painting)

Alchemists worked with equipment like this.

were called alchemists. Their methods were crude, but they were discovering some of the principles of modern chemistry. They tried things out. They had no sure methods for research but just put things together, boiled them, distilled them, and even said magic formulas over them. They still did not know what was reasonably possible and what was not. Some of them hoped to be able to change cheaper and more abundant materials into gold. Some hoped to find ways of keeping people from growing old or ways to keep them alive forever. Others were just trying to find out about the world.

The scientist in the second picture knows exactly what he is doing. He knows all that other scientists have done in his field. He has properly designed apparatus. He knows what may reasonably be expected as a result of his work and what may not. Finally, he knows that he will

probably not learn anything very far beyond what is already known. He will be very happy if he can add just a little to the total of human knowledge.

Which scientist would you rather be like? You may not want to be a scientist at all, but whatever you do, it is your responsibility to know all that is to be known about your job. Those who worked out techniques made many mistakes. There is no need for you to make the same mistakes. There is a great heritage of knowledge waiting for you, worth far more than all the gold in the world. It is your responsibility to make sure you claim your share.

Your second great responsibility is to keep an open mind. Do not be too ready to say, "It can't be done." This book tells you about any number of things that people once said could not be done. It is the people who believe that things can be done who get results in this working world. They are the people who keep trying.

Your third responsibility is work. The world is full of resources. Through those re-

The modern scientist has amazing new techniques and equipment.

Stephen Deutch, Courtesy Abbott Laboratories



sources you can have many wonderful things, but you cannot have them without work—your work or the work of someone else. You will be happier if you do your own share of the world's work.

Your share of the world's work is not just something you can do with your hands. The people whose work really counts use their minds as well as their hands. They are the

inventors—the ones who make technological progress possible, who raise the world's standard of living, who give people more goods to use, better health, and a greater opportunity to enjoy their lives. If our world is ever to become a better world, then people must make it so. Some of the students who read this book will be among the inventors and discoverers. Will you be one of them?

A WORKSHOP ON THE WORLD'S WORKERS

In reading about the world's work and workers, have you found any work you would like to do? Have you changed your mind since you have learned more about the kinds of work there are in the world? Prepare a short talk about the kind of work you would like to do and why you would like it. Tell just what you would be doing, what knowledge and skills you would need, and how you might go about getting the necessary training and experience. If you know anyone who does the kind of work you would like to do, learn as much as you can from him.

Your Community as a Laboratory

Turn to the table of contents at the beginning of this book and read the titles of the chapters. The first title is an introduction to the book. Then come chapters on hunters and fishermen, farmers, forest workers, and miners. All the people in these industries are busy getting food or raw materials from the earth. Their work is of basic importance. Without them no other kind of work could go on in the world.

Over most of the world people could not live without fuel. Modern industries are impossible without power. Even the production of raw materials by modern methods would be impossible without great quantities of power. You had a whole chapter on the production and use of power.

Then you studied a long chapter about processing and manufacturing—the work of turning raw materials into useful products. In the United States there are more workers in the groups covered by this chapter than in any other except the service industries. In some of the countries of western Europe (see

page 389) there are even more workers in manufacturing than in the service industries. There is no country in the world that does not have at least a few workers in this group.

Workers in transportation, communication, and trade tie together the work of all the rest. Without them we should have no choice of occupation. We should all be primitive hunters and fishermen or at best subsistence farmers.

Then there are all the people in the service industries. This book does not have a chapter about them, but you can see that they are important because there are so many of them. Without them other people would not be able to do their work well or live comfortably. You read a little about them in this chapter.

Your community has people in every group of industries. If you have carried out the activities in all the Workshops, you have had a chance to see work going on as well as to read about it. That is what has been meant all along by using your community as a laboratory. You had a chance to see workers in every occupational group, to talk to them, and to watch them work.

Through your study of work in your own community, you were better able to understand the work of the world. You had seen work that was more or less like the work you were studying. Thus your community became a laboratory. A laboratory is not necessarily a room filled with strange apparatus, such as scientists use. A laboratory is a place in which people learn by observation and experiment. In all your community studies, you have been learning by observation and experiment. Perhaps you have even had a chance to experiment for yourself with some of the work of the world.

REPORT TO THE COMMUNITY

While you were learning about the world through your community, you learned many things about the community itself. Wouldn't you like to tell your neighbors how much you know about their work? Perhaps you could arrange an exhibit for the end of your study of the working world. Invite the people of your community to see it.

In planning your exhibit, think about what will be most interesting to the people of your community. They are most likely to be interested in things related to their own work and their own everyday living. Here are a few suggestions for things you might do. When you begin to plan, you will think of others.

1. Copy on large sheets of paper some of the occupation graphs in the Atlas Section at the back of this book. At least one of them should include your own community. If you live in Detroit, for example, you might show a copy of the graphs for Detroit, the Middle Western United States, and the whole of the United States. Then you might have the United States in 1840 and some of the other countries of the world for comparison.

2. If you live in or near one of the cities named in the graph on page 361, copy the graph on a wall chart.

3. Collect and label samples of the products of your community.

4. Find products for sale or in use in your community that have come from other regions in North America or in other continents. Run colored strings or ribbons from your samples to the proper places on a wall map of the world.

5. If your community has an industry that uses materials from a number of sources, set up the same kind of map exhibit for that industry.

6. Arrange an exhibit of photographs of people at work in your community.

7. If any of you has a moving picture camera, take movies of people at work and show the pictures to your guests.

8. Arrange a number of copies of this book on a table, opened to show a number of maps, graphs, and pictures that you think would be especially interesting to the people of your community.

9. Post a list of the industries and the kinds of work done in your community. Even

grown people who are workers themselves will be surprised at the number of different kinds of work.

10. Have someone stationed at each exhibit to tell your guests about it and answer any questions they may wish to ask.

YOU ARE A CITIZEN OF YOUR COMMUNITY

Most of this book has been about paid workers. There are other workers, too. Millions of housewives are not counted in the statistics of workers, but they work just as hard and their work is just as necessary as the work of paid workers. Homes must be kept in operation. Have you any tasks to do at home? If you have, you are one of the workers of your community. If it is your job to mow the lawn, then the good appearance of the community depends partly upon how well you do your work.

Are any projects for the improvement of the community being carried out? It is your job to join the other citizens of your community in such projects.

ADDITIONAL INFORMATION

In this chapter you have read about new industries and new techniques. You have read about scientific research and discoveries. As this book is written many scientific problems seem just on the point of solution. New methods of working are being tried out. Many new inventions are still in the experimental stage.

Almost every newspaper and magazine has something to say about new discoveries in medicine. They are of interest to everyone. One of those new discoveries may save your life some day.

For information on all these subjects you will have to read newspapers and magazines. Learn to watch for news about such things as atomic power, for example. A number of magazines are published just to tell people about new inventions and discoveries.

You have completed a year's study of the working world. No one will ask you questions about what you learn from now on. No one will give you a grade on how well you have understood what you read in the newspaper. Your reward will be the satisfaction of being a well-informed person, living in an intensely interesting world.

Reference Tables

Area and Population of the Continents Except Antarctica

	AREA IN SQUARE MILES	POPULATION
Africa . . .	11,600,000	187,800,000
Asia	16,793,000	1,315,000,000
Australia . .	2,974,581	7,912,000
Europe . . .	3,762,000	524,400,000
North America .	9,375,000	215,900,000
South America .	6,846,000	108,239,000

Area and Population of the Principal Countries of the World

EUROPE		
Austria	32,375	7,090,122
Belgium	11,779	8,625,084
Bulgaria	42,796	7,160,000
Czechoslovakia	49,354	12,463,000
Denmark	16,576	4,230,000
Finland	130,159	4,015,000
France	213,009	41,180,000
Germany	137,591	68,628,000
Greece	51,182	7,852,000
Hungary	35,912	9,400,000
Iceland	39,698	140,968
Ireland (Eire)	27,137	2,991,000
Italy	116,224	46,120,926
Luxembourg	998	295,000
Netherlands	13,025	9,956,000
Norway	125,182	3,233,000
Poland	120,359	24,500,000
Portugal	35,414	8,491,000
Romania	91,700	15,872,624
Soviet Union (In Europe and Asia)	8,436,000	193,500,000
Spain	194,232	28,514,874
Sweden	173,423	6,956,000
Switzerland	15,944	4,650,000
Turkey (<i>See</i> <i>under</i> Asia)		
United Kingdom	94,278	50,363,000
England	50,874	40,386,800
Northern Ireland	5,237	1,359,798
Scotland	30,405	5,169,217
Wales	7,466	2,552,200
Yugoslavia	99,181	16,250,000

ASIA

Afghanistan . .	245,000	12,000,000
Burma	261,610	17,700,000
Ceylon	25,332	7,297,000

	SQ. MILES	POPULATION
China	3,850,000	463,493,000
Formosa	13,885	6,384,019
Manchuria . . .	503,144	37,461,358
Tibet	469,194	1,000,000
India	1,246,880	347,340,000
Indochina . . .	272,355	27,030,000
Indonesia . . .	575,893	79,260,000
Java and Madoera . . .	51,032	50,000,000
Sumatra	164,198	10,000,000
Iran	628,000	15,000,000
Iraq	168,243	4,799,500
Israel	7,951	1,250,000
Japan	142,338	82,636,000
Korea	85,266	29,291,000
Malaya	50,660	5,003,728
Mongolia	558,054	880,000
Pakistan	361,520	74,436,942
Philippines . .	115,600	19,356,000
Saudi Arabia . .	413,792	5,500,000
Siam	198,271	17,987,000
Soviet Union (<i>See under</i> Europe)		
Syria	66,063	3,513,024
Turkey	296,185	19,623,000

AFRICA

Algeria	851,312	8,665,800
Anglo-Egyptian Sudan	969,600	7,931,150
Angola	481,351	4,495,000
Belgian Congo	925,907	15,014,076
British Somaliland . . .	68,000	700,000
Cameroons . . .	166,489	2,801,455
Egypt	386,000	20,045,000
Ethiopia	350,000	7,500,000
French Equatorial Africa	965,250	4,127,808
French Somaliland . . .	8,378	44,800
French West Africa	1,774,593	16,535,300
Gold Coast . . .	91,843	4,095,276
Kenya	224,960	5,373,000
Madagascar . .	228,571	4,350,000
Morocco (Fr.) .	161,639	8,617,387
Mozambique . .	297,731	6,251,000
Nigeria	372,674	25,000,000
Northern Rhodesia	284,745	1,644,800
Southern Rhodesia	150,327	2,022,000
Southwest Africa	317,725	361,075
Tanganyika . . .	342,706	7,412,327
Tunisia	64,633	3,230,952
Uganda	93,981	4,927,000
Union of South Africa . .	472,494	12,112,000

AUSTRALIA AND NEW ZEALAND

Australia . . .	2,974,581	7,912,000
New Zealand . .	103,416	1,881,000

NORTH AMERICA

	SQ. MILES	POPULATION
Alaska	586,400	128,643
Canada	3,843,144	13,845,000
Central America	228,616	9,981,659
Greenland	839,999	21,384
Mexico	760,373	24,448,000
United States . .	3,022,387	150,697,361
West Indies . . .	80,911	13,049,630
Cuba	44,217	5,199,000
Dominican Republic	19,131	2,277,000
Haiti	10,714	3,700,000
Jamaica	4,411	1,350,000
Virgin Is. (U.S.A.)	133	27,000

SOUTH AMERICA

Argentina	1,074,209	16,105,626
Bolivia	415,364	3,990,000
Brazil	3,286,111	50,700,000
British Guiana . .	82,997	388,288
Chile	286,396	5,770,000
Colombia	439,828	11,015,000
Ecuador	100,613	3,467,399
French Guiana	35,135	28,537
Paraguay	157,047	1,304,000
Peru	482,258	8,240,000
Surinam	55,143	213,700
Uruguay	72,172	2,353,000
Venezuela	352,143	4,696,600

Area and Population of the United States

Alabama	51,609	3,061,743
Arizona	113,909	749,587
Arkansas	53,102	1,909,511
California	158,693	10,586,223
Colorado	104,247	1,325,089
Connecticut . . .	5,009	2,007,280
Delaware	2,057	318,085
District of Columbia	69	802,178
Florida	58,560	2,771,305
Georgia	58,876	3,444,578
Idaho	83,557	588,637
Illinois	56,400	8,712,176
Indiana	36,291	3,934,224
Iowa	56,280	2,621,073
Kansas	82,276	1,905,299
Kentucky	40,395	2,944,806
Louisiana	48,523	2,683,516
Maine	33,215	913,774
Maryland	10,577	2,343,001
Massachusetts . .	8,257	4,690,514
Michigan	58,216	6,371,766
Minnesota	84,068	2,982,483
Mississippi . . .	47,716	2,178,914

United States (cont.)

	SQ. MILES	POPULATION
Missouri.....	69,674	3,954,653
Montana.....	147,138	591,024
Nebraska....	77,237	1,325,510
Nevada.....	110,540	160,083
New Hampshire	9,304	533,242
New Jersey...	7,836	4,835,329
New Mexico...	121,666	681,187
New York.....	49,576	14,830,192
North Carolina	52,712	4,061,929
North Dakota...	70,665	619,636
Ohio.....	41,222	7,946,627
Oklahoma....	69,929	2,233,351
Oregon.....	96,981	1,521,341

	SQ. MILES	POPULATION
Pennsylvania.	45,333	10,498,012
Rhode Island	1,214	791,896
South Carolina	31,055	2,117,027
South Dakota	77,047	652,740
Tennessee....	42,246	3,291,718
Texas.....	267,339	7,711,194
Utah.....	84,916	688,862
Vermont.....	9,609	377,747
Virginia.....	40,815	3,318,680
Washington...	68,192	2,378,963
West Virginia	24,181	2,005,552
Wisconsin....	56,154	3,434,575
Wyoming....	97,914	290,529

Area and Population of the Provinces of Canada

	SQ. MILES	POPULATION
Newfoundland	152,734	355,000
P. Edward I..	2,184	96,000
Nova Scotia..	21,068	658,000
New Brunswick	27,985	522,000
Quebec.....	594,860	3,976,000
Ontario.....	412,582	4,512,000
Manitoba....	246,512	795,000
Saskatchewan	251,700	874,000
Alberta.....	255,285	895,000
Br. Columbia	366,255	1,138,000
Yukon Ter. . .	207,076	8,000
Northwest Territories	1,304,903	16,000

Working Populations by Occupation Groups

The tables below list the number of workers in the various occupation groups for twelve selected countries. The countries were chosen from different parts of the world and from areas with different types of culture. The classifications are not exactly the same for all countries. More interesting comparisons could be made if they were all alike, but each country makes its own grouping from its own census figures.

PERU

Working Population: 2,475,339

Agriculture, forestry, fishing, hunting.....	1,546,189
Mining and quarrying....	44,694
Manufacturing.....	380,281
Construction.....	45,659
Transport and communication.....	51,079
Trade.....	112,126
Service industries.....	286,311

FRANCE

Working Population: 21,611,835

Agriculture, forestry, fishing.....	7,704,180
Mining and quarrying....	440,677
Manufacturing.....	6,837,684
Transport and communication.....	1,069,356
Trade.....	2,695,390
Service industries.....	2,864,548

BELGIUM

Working Population: 3,750,285

Agriculture, forestry, fishing.....	637,604
Mining and quarrying....	221,692
Manufacturing.....	1,570,108
Transport and communication.....	256,105
Trade.....	543,757

NETHERLANDS

Working Population: 3,185,816

Agriculture and fishing....	655,190
Mining.....	51,449
Manufacturing.....	1,184,463
Transport and communication.....	296,737
Trade.....	447,242
Service industries.....	243,555

SWEDEN

Working Population: 2,999,526

Agriculture, forestry, fishing.....	864,011
Manufacturing and mining	1,070,209
Transport and communication.....	201,459
Trade.....	408,982
Service industries.....	420,734

ITALY

Working Population: 18,345,432

Agriculture, forestry, fishing.....	8,842,785
Mining and quarrying....	128,446
Manufacturing.....	5,246,706
Transport and communication.....	702,201
Trade.....	1,605,363
Service industries.....	1,819,931

SWITZERLAND

Working Population: 1,942,626

Agriculture, forestry, fishing.....	413,336
Mining and quarrying....	7,482
Manufacturing.....	867,037
Transport and communication.....	84,998
Trade.....	190,213
Service industries.....	379,560

NORWAY

Working Population: 1,042,662

Agriculture and forestry...	336,364
Fishing and hunting.....	75,977
Manufacturing and mining	309,813
Transport and communication.....	108,422
Trade.....	126,379
Service industries.....	85,707

CZECHOSLOVAKIA

Working Population: 6,992,313

Agriculture, forestry, fishing.....	2,679,696
Mining.....	128,329
Manufacturing.....	2,396,032
Transport and communication.....	287,637
Trade.....	571,894
Service industries.....	821,910

YUGOSLAVIA

Working Population: 6,477,815

Agriculture, forestry, fishing.....	5,098,888
Manufacturing and mining	717,002
Transport and communication.....	102,385
Trade.....	169,964
Service industries.....	305,770

BULGARIA

Working Population: 3,433,103

Agriculture.....	2,744,927
Mining and quarrying....	8,356
Manufacturing.....	266,405
Transport and communication.....	43,389
Trade.....	80,904
Service industries.....	202,180

JAPAN

Working Population: 29,619,640

Agriculture.....	13,964,765
Fishing.....	546,624
Forestry.....	175,342
Mining.....	251,220
Manufacturing.....	5,699,581
Transport and communication.....	1,107,574
Trade.....	3,255,215
Service industries.....	4,048,353

Index and Pronouncing Vocabulary

A star (*) indicates a picture.

Key to pronunciation: *ā*, as in *āte*; *â*, as in *senâte*; *â*, as in *câre*; *ă*, as in *ăm*; *ǎ*, as in *finǎl*; *ä*, as in *ärm*; *á*, as in *ask*; *ä*, as in *sofä*; *ē*, as in *ève*; *ē*, as in *erëate*; *ē*, as in *ënd*; *ē*, as in *novēl*; *ē*, as in *cindēr*; *ī*, as in *ice*; *ÿ*, as in *ÿll*; *ō*, as in *old*; *ō*, as in *ōbey*; *ô*, as in *lôrd*; *ö*, as in *ödd*; *ö*, as in *cönnect*; *oo*, as in *fööd*; *oo*, as in *fööt*; *ou*, as in *thou*; *û*, as in *püre*; *û*, as in *ünite*; *û*, as in *ûrn*; *ü*, as in *stüdy*; *ž*, as in *circžs*; *ŋ*, like *ng*, for *n* before the sound of *k* or hard *g*, as in *banŋ*; *n* indicates the nasal tone, as in French, of the preceding vowel; *g*, as in *go*; *th*, as in *that*; *k*, as in German *ich*.

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For Teacher Reference

Pages v and vi of the Introduction list the objectives of *Geography of a Working World* as a geography text. But learning in the social studies should be two-dimensional. The study of every subject should also contribute to social competence and to desirable social attitudes. To make most effective use of this book, read the materials on this page before you begin the year's work. The references will help you to find portions of the text especially intended to contribute to this second and higher level of learning.

I. Skills Necessary for Social Competence

Reading maps, graphs, and diagrams

One of the map skills to be acquired at this level, if it has not been acquired earlier, is self-reliance. Pupils should learn to look up map data for themselves when they need the information. The references listed below are the numbers of pages on which pupils are told to use maps for special purposes. The maps, graphs, and diagrams are listed in the Index.

Maps: general discussion, 299, 361-363; Atlas section as a whole, 3, 10, 68, 74, 83, 115, 164, 339; climatic, 10, 16, 58-59, 68, 70, 72, 94, 98, 102, 126, 130, 279; farming, 63, 82, 88, 90, 94, 95, 99, 100, 104, 105, 115, 209, 211, 220; forests, 120, 124, 128, 129; globe, 18, 50, 279, 294, 324; hunting and fishing, 23, 26, 34, 45; manufacturing, 207, 209, 214, 270; mining and minerals, 144, 159, 161, 162, 163, 170, 173, 174-175, 181; ocean currents, 280, 299-300; physical-political, 10, 16, 30, 58, 92, 93, 128-129, 135, 157, 158, 161, 163, 164, 167, 196, 244, 301-302; population, 9, 10-14, 15, 16-20, 21-22, 26, 28, 58, 68, 83, 91, 95, 99, 102, 104, 126, 156, 196, 207, 209, 214, 271, 284, 314, 325; power, 184, 195, 196, 197, 199; transportation and trade, 271, 308, 309, 310, 323-324, 325, 326; vegetation, 10, 28, 29, 58, 90, 102, 120, 126, 130, 132; Workshop activities requiring map skills, 113-114, 141, 181, 270, 298, 299-300, 328

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Vocabulary skills

Three types of new words are introduced in *Geography of a Working World*. First, there are new geographic terms, such as *range* (of an animal or plant), page 34; *seasonal rainfall*, page 58, and *wind belts*, page 279.

Second, there are words which are needed in the discussion of the world's work—such terms as *metropolitan district*, *hybrid*, *synthetic*. No great effort need be made to teach most of them.

The third class is not large. It is made up of terms standing for concepts that reach beyond the goals of geography alone and contribute to the goals of all social-studies education. They are concerned with that second level of learning which should express itself in changed attitudes, in more mature social understandings and social competence. Such terms are introduced with great care after a background has been provided. No attempt is made to attach all possible meanings and usages to the terms when they first appear. Meaning is enlarged and enriched by repeated use of the terms in varying contexts.

The following list gives only the page on which a term is introduced. See the Index and the references under II below for other materials associated with the terms.

New terms to express social understandings: basic invention, 145; capital, 84; consumers, 209; culture, 26; division of labor, 147; interdependence, 336; levels of technology, 191; mechanized and mechanization, 85; money, 7; primitive, 25; service industries, 7; standardization, 87; standard of living, 67

Use of personal and community experiences

The ability to see the relationship between textbook learning and personal experience in the community is a definite geographic and social skill. *Geography of a Working World* provides guidance in developing this skill.

References to pupil experiences: 3, 23, 40, 44, 48, 53, 70, 73, 110, 119, 120, 128, 139, 143, 149, 150, 161, 167, 183, 184, 188, 189, 193, 197-198, 202, 204, 205, 212, 213, 219, 223, 225-226, 228, 251, 252, 266, 269-

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Critical thinking

All true understanding of cause-and-effect relationships involves critical thinking. Most of the content of this text provides pupils with opportunities to develop the skill. In a few places children are specifically asked to challenge obvious answers, reach conclusions about relative values, or solve problems by eliminating possible choices.

For critical thinking: 8-9, 10-11, 21, 22, 51-52, 115, 118, 133-134, 136, 184, 202, 267, 269, 270, 298, 300, 328, 341

II. Major Social Understandings

Conservation

Geography of a Working World emphasizes wise use of resources rather than mere abstention from use. On the pages listed below the term is sometimes used, sometimes not. Pupils should be able to explain how the text is related to conservation even when the term is not used.

References on conservation: 29, 42, 49, 50, 63-64, 67, 73, 74, 76, 78, 86, 89, 95-96, 119-120, 122, 131, 133-139, 156, 173, 176-177, 189-190, 196-197, 201-202, 208, 209, 216, 267, 334, 336

Culture patterns and cultural change

Peoples with different patterns of culture make different adjustments to their environment—use resources in different ways. Understanding of such cultural differences and how they affect the relationships between groups of people and the earth is one of the major objectives of *Geography of a Working World*.

References on cultures (with and without use of term): culture patterns, 24-25, 26-29, 55-57, 58, 59-62, 63, 64-77, 78-79, 82, 83-84, 120-121, 150-151, 156, 207-210, 226, 275, 288-289, 303, 304-305, 306, 308, 330-331, 332-333, 337; cultural change, 27-28, 55-56, 66, 68, 72, 77-82, 89-92, 112-113, 147, 153, 154-155, 164, 184-187, 189, 210, 226-228, 275, 287, 295, 304, 305-306, 330-331, 341

Relation between technology and standard of living

Increasingly effective use of the environment through technological progress results in a higher standard of living by providing more goods for more people. Although the concept is never stated so formally in the text, the idea is a major theme in *Geography of a Working World*. Note the phrase "more people" in the statement of the theme. It is as important as the "more goods."

More goods for more people: 9, 15, 16, 18-19, 20-21, 25, 28, 43, 47, 54-55, 63, 67, 68, 70, 75, 77, 79, 80, 81-82, 83-84, 88, 98, 103-104, 105, 111, 113, 135, 144-145, 150, 151, 153-154, 156, 172, 189-190, 198-199, 220-221, 224, 225, 282, 283-284, 286, 306-308, 317-318, 324, 326, 330, 331, 333, 340, 341, 347

Interdependence of individuals and groups

The need for interdependence, for cooperation of individuals and groups, is another major theme in *Geography of a Working World*. Since this book is about the world's work, the theme is developed through topics concerned with work. The term "interdependence" is not introduced until the last chapter. If you wish to make the most of this understanding, read the material on pages 335-341 before you begin the year's work.

Interdependence: 8-9, 12, 42, 49, 56, 58, 69, 77, 79, 80, 87, 89, 93-94, 97, 106, 109-110, 147, 171-172, 177, 191-193, 205-206, 230, 231-232, 249, 258-260, 262-263, 286, 296, 297, 314-321, 329-330, 331-342, 343

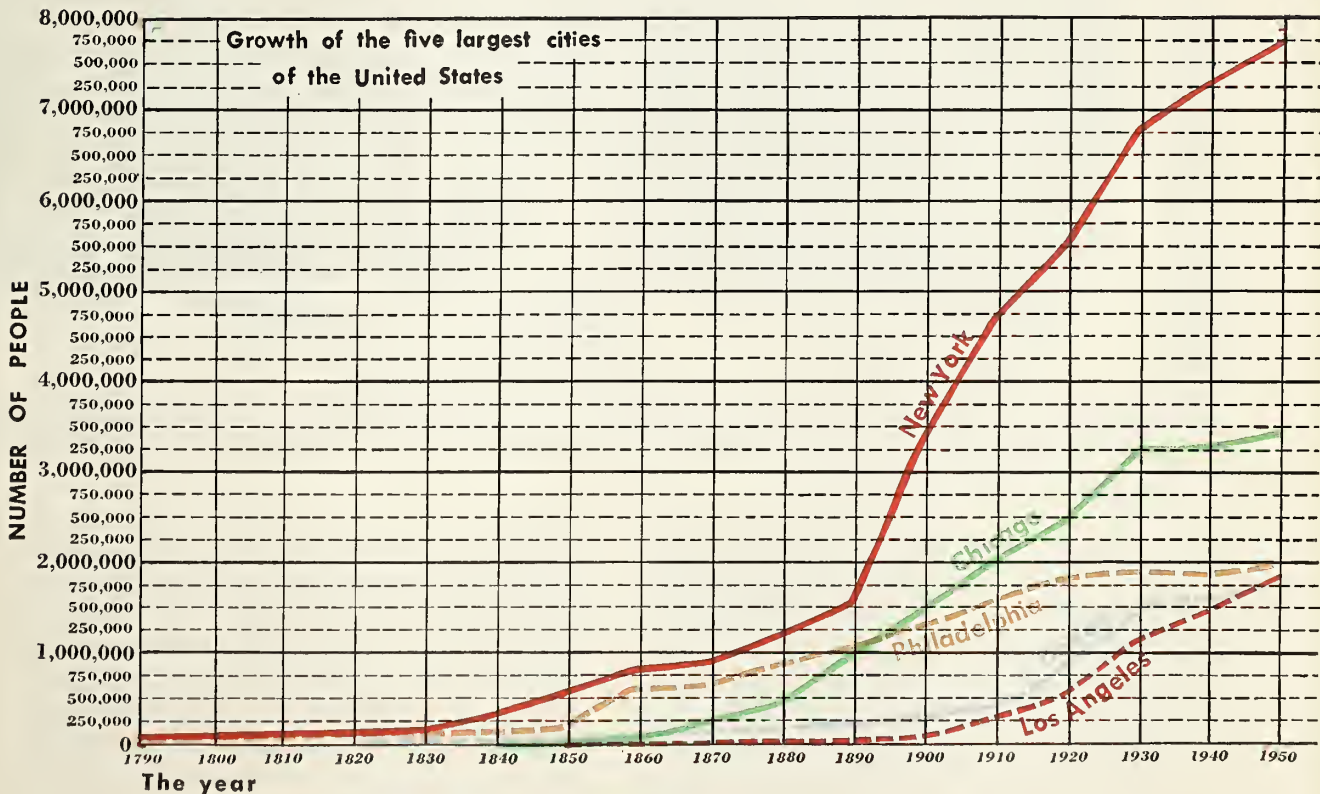
Atlas Section

An atlas is a book of maps. The following pages are an atlas bound into your textbook. The maps and graphs on these pages are the ones you need to use often as you read. They have been placed together in the back of the book, where you can find them easily.

Besides the maps, this Atlas section has a number of graphs. Graphs are based on *statistics*. The word statistics is just a grown-up term for information in the form of figures. A graph is easier to understand than a table of statistics. In a graph, you can see the important information at a glance. For example, compare the graphs that show occupations on pages 380-381 with the figures on page 350. They give you the same kind of statistical information. Which means more to you at a glance?

Throughout the textbook there are many other maps and graphs. They make the text

easier to understand where they appear, but you do not need to use them over and over again. They show one or two things only. The maps and graphs in this Atlas section have more information on them. To make them easier to understand, they are in color. Compare the graph at the bottom of this page with the one on page 14. The graph on page 14 shows the growth of just one city. The one line is clear and easy to understand. On the graph below there are lines for five cities. You could not follow the five lines if they were all alike; but with the lines in different colors, they are easy to follow. That is the reason for using color. Color on a map or graph is not meant just to make it look prettier. Color is a symbol which you should learn to read. It is there to make the map or graph easier to read and to make its meaning easier to understand.





A physical-political map of the world.

Comparisons between this map and the world maps that follow will reveal much that is interesting, useful, and even exciting in geographical understandings. The locations of areas of dense population and the growth and development of large cities, for example, are closely related to land elevation, free access to ocean commerce, rainfall, growing season,

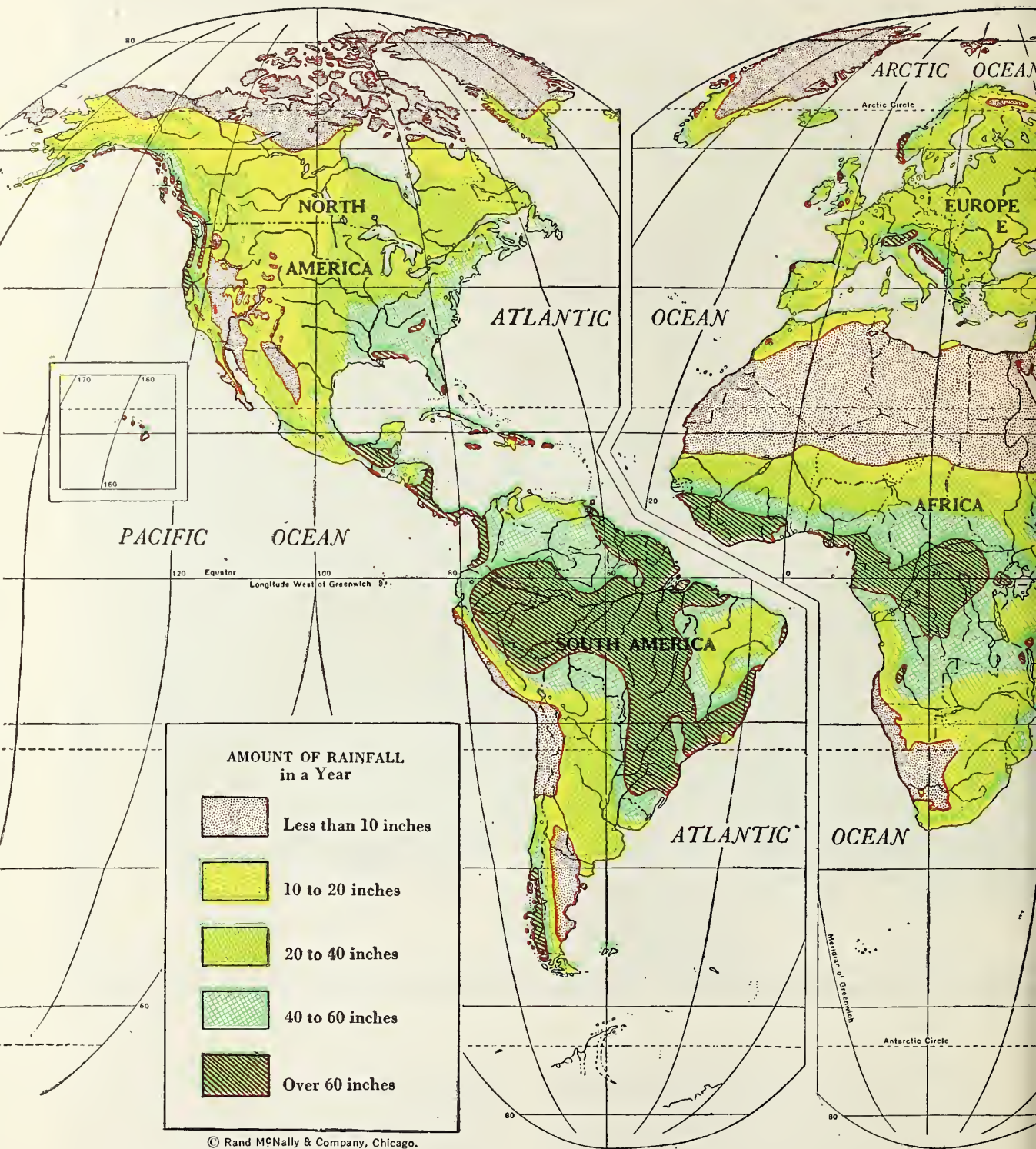
climate, and vegetation. If you will establish the habit of making frequent comparisons between the world map above and those immediately following, you will have gone a long way toward building an adequate understanding of the effects of geography on the different ways people live in the various parts of the world.

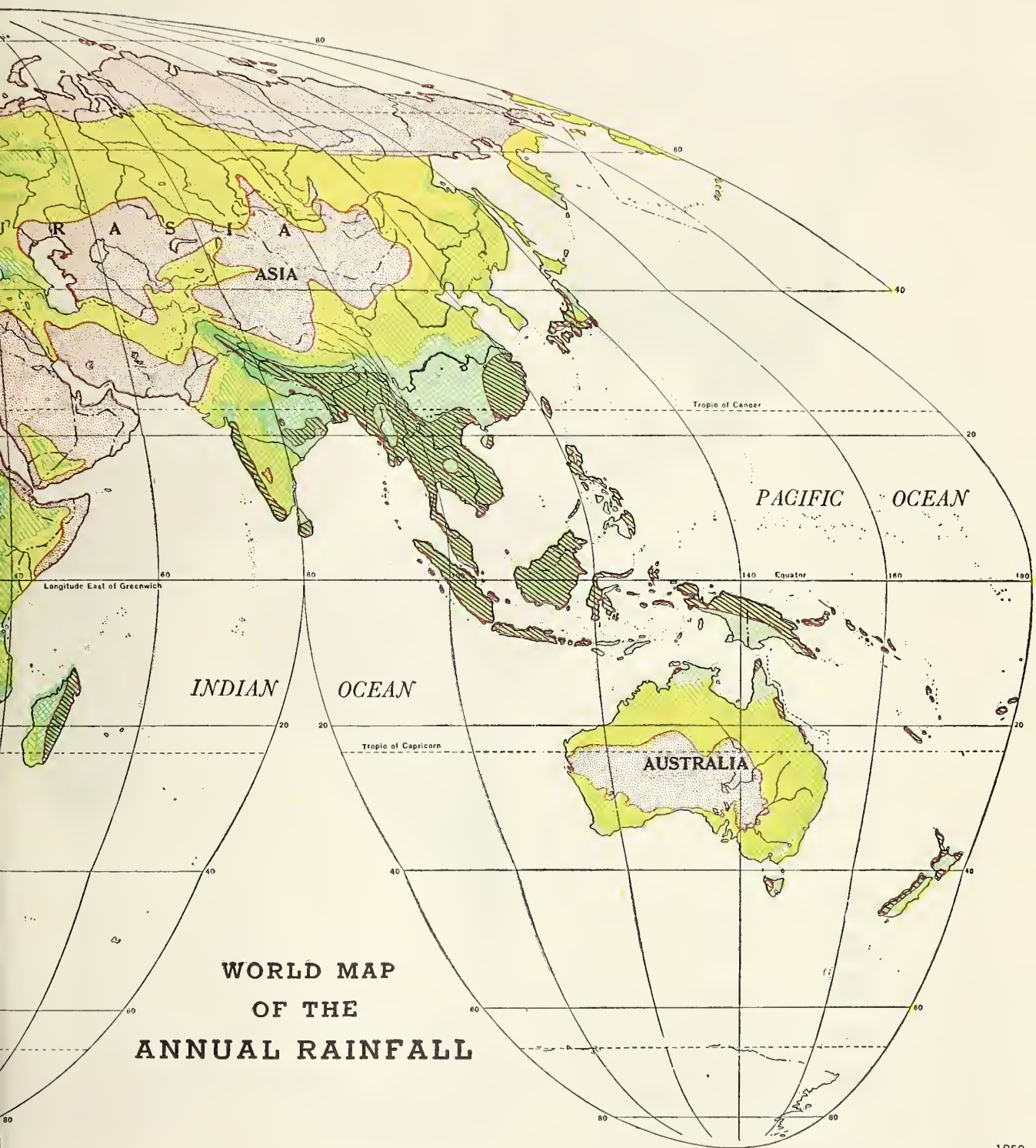


Wherever men live and work, the environment exercises a profound influence on their lives. To understand their environment will help you to understand their problems. Part of the reason people behave as they do is because of their social environment—their history, their beliefs, and their special ways of doing things. But the building up of these

things depended, in part, on the natural or geographical environment in which the people have lived.

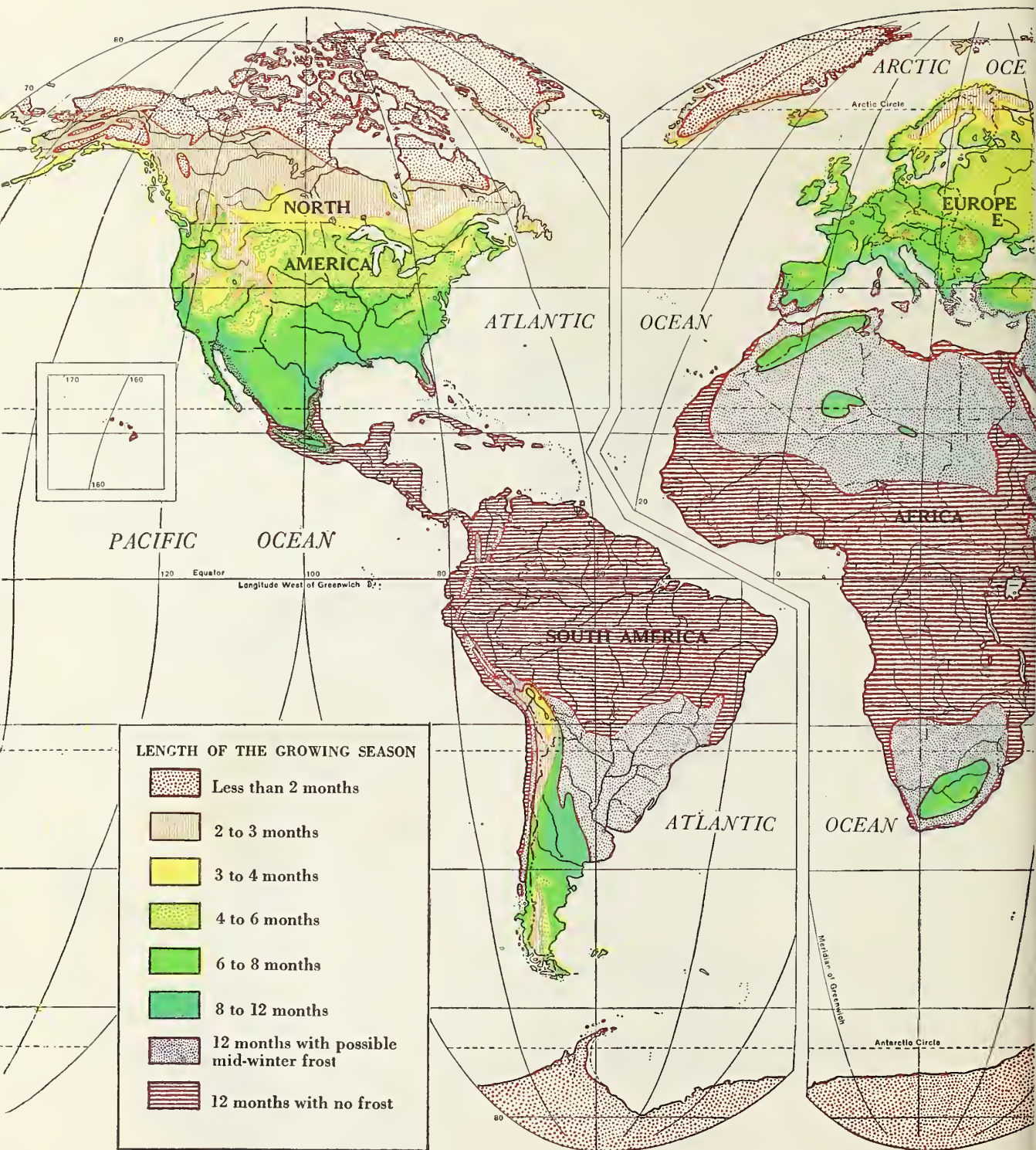
In this book many challenging problems will be presented. Much information will be provided to help you understand these problems. You will often be referred to these world maps. Learn to use them.



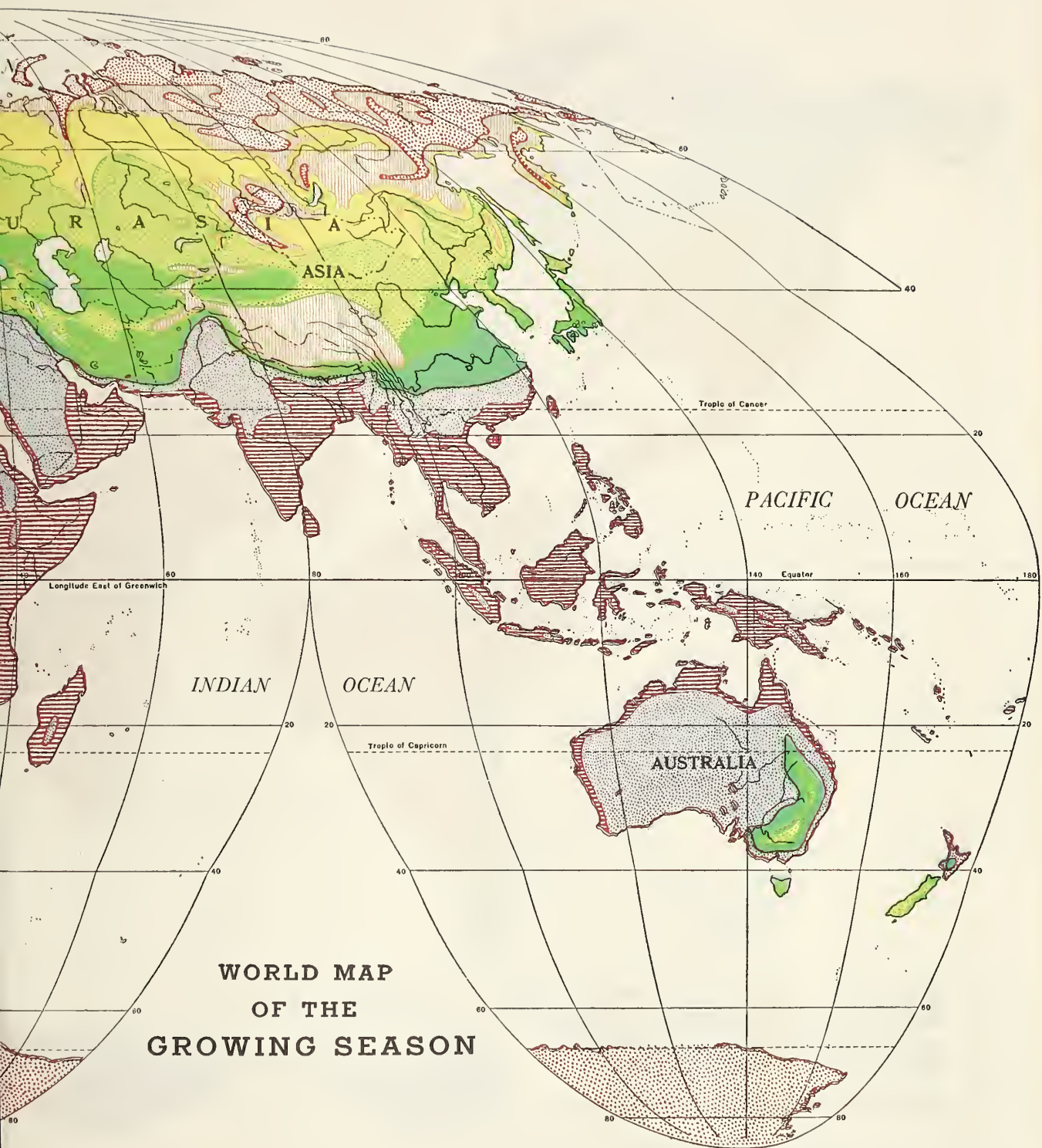


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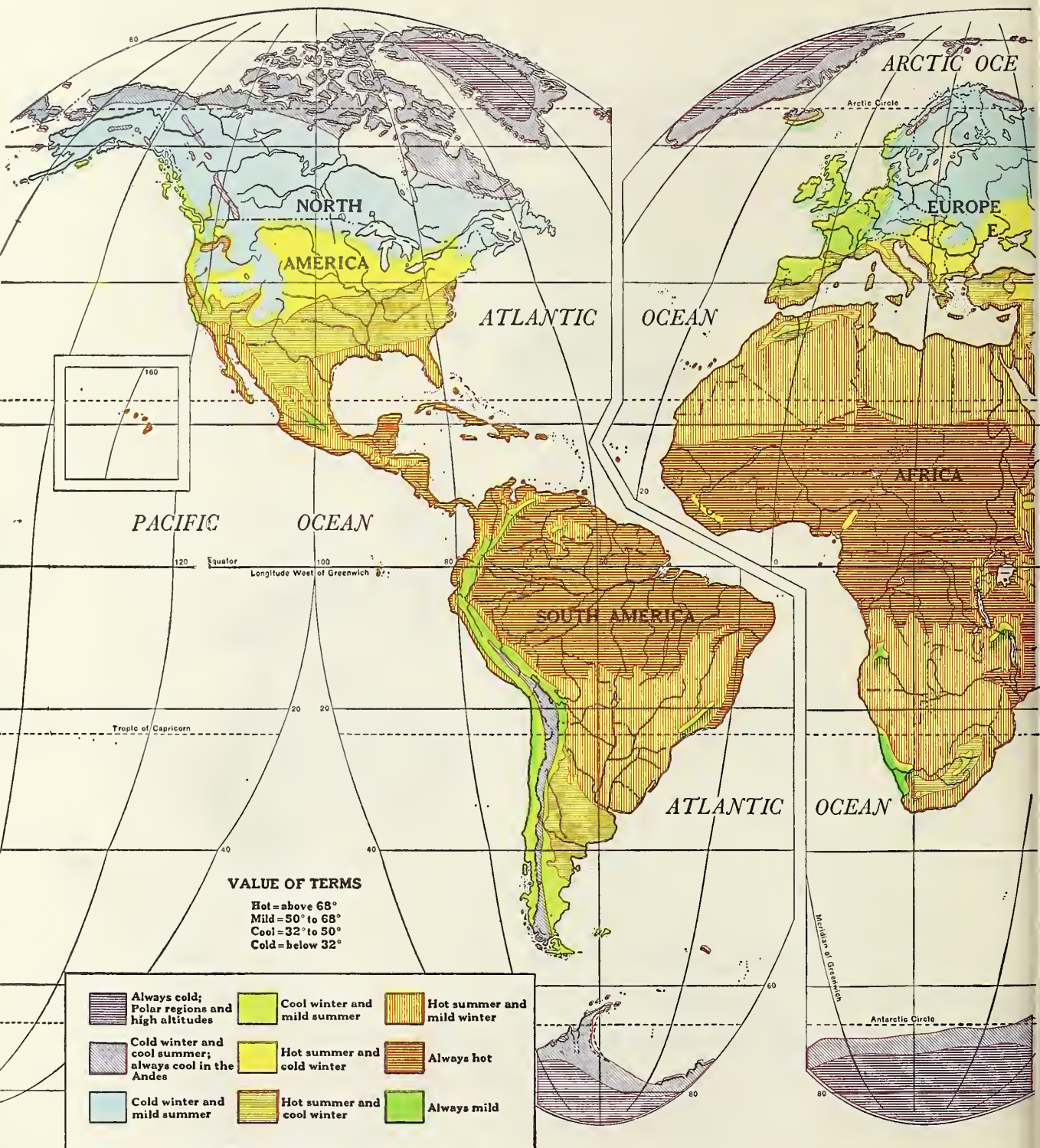


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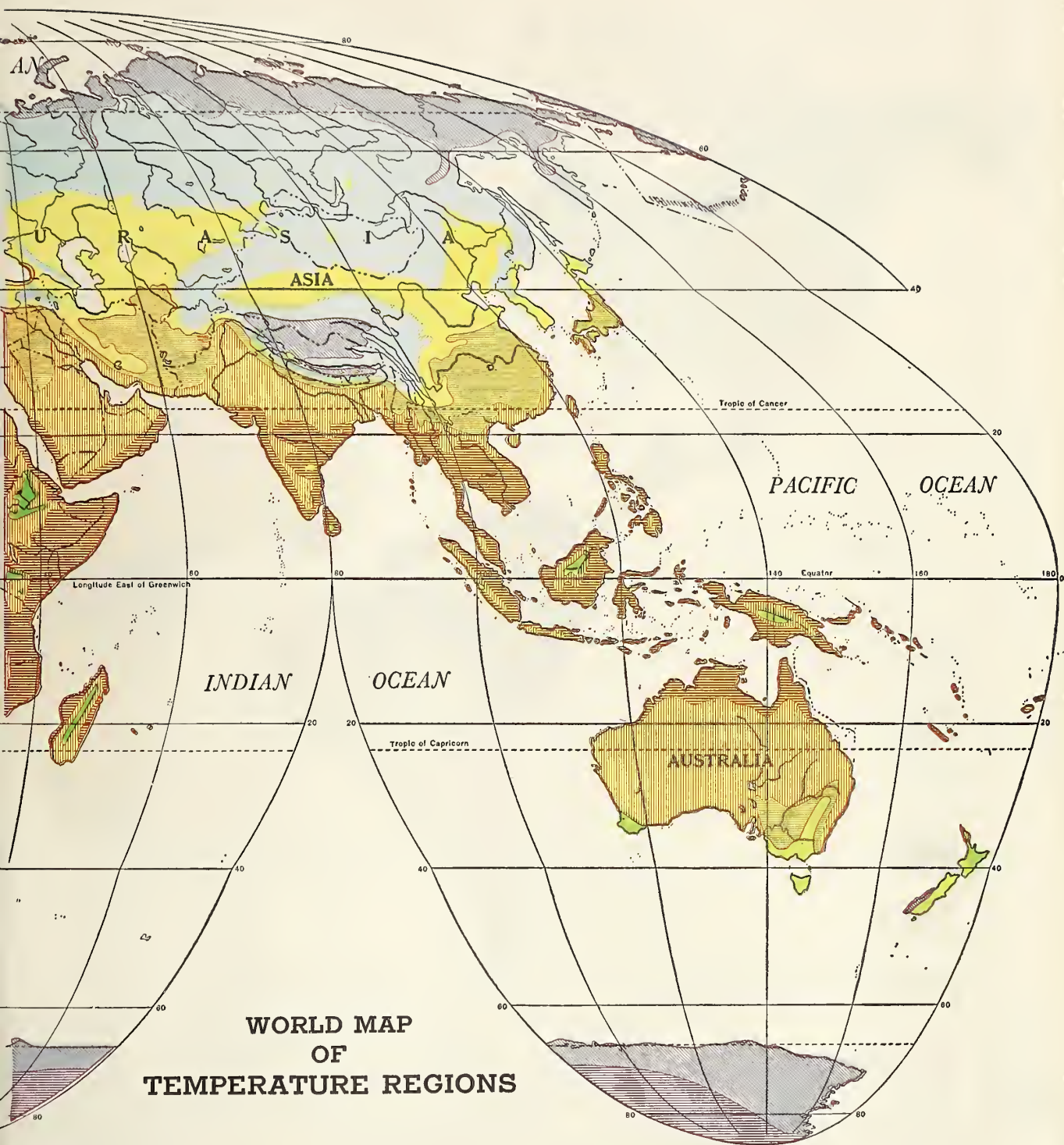


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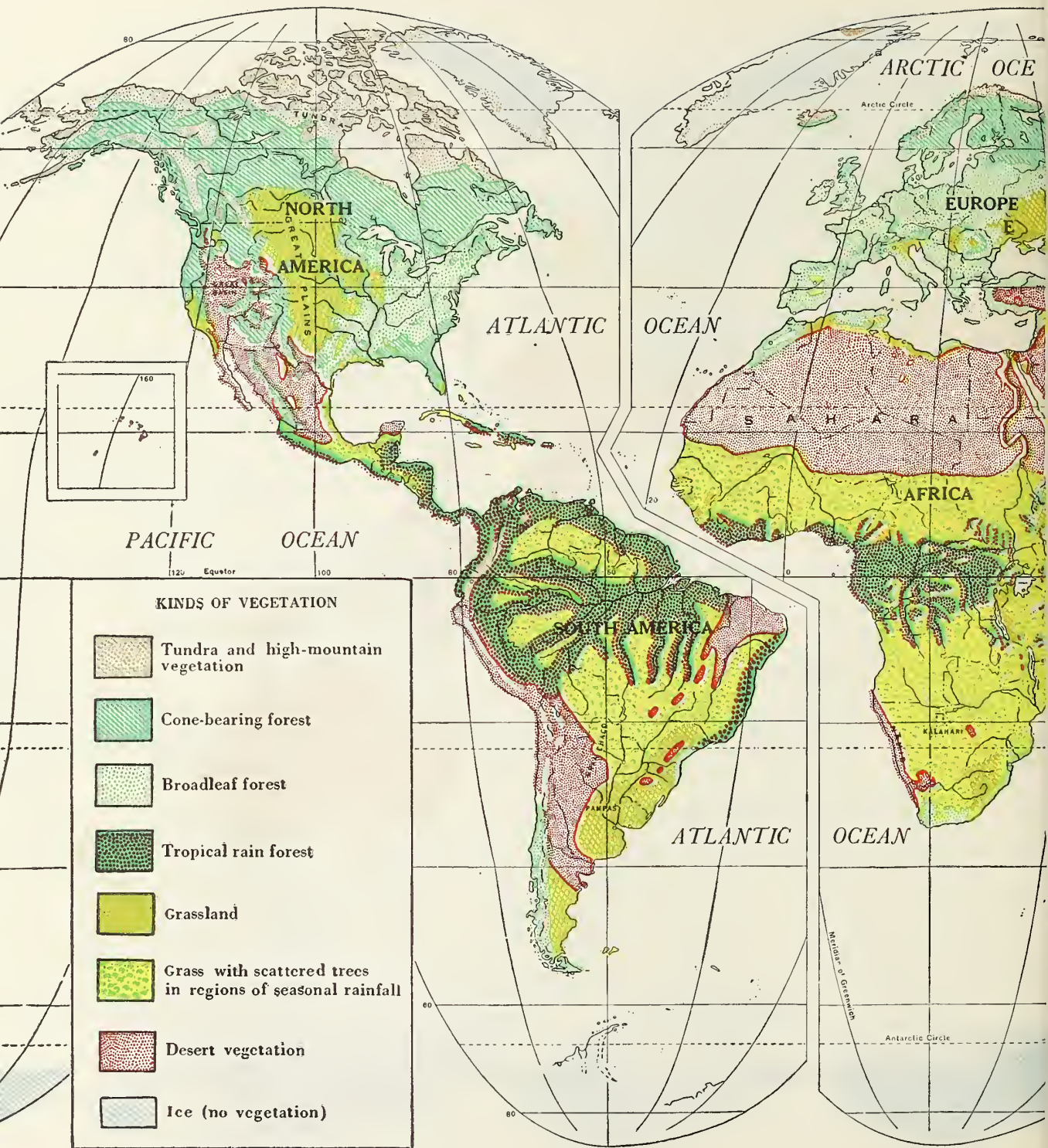


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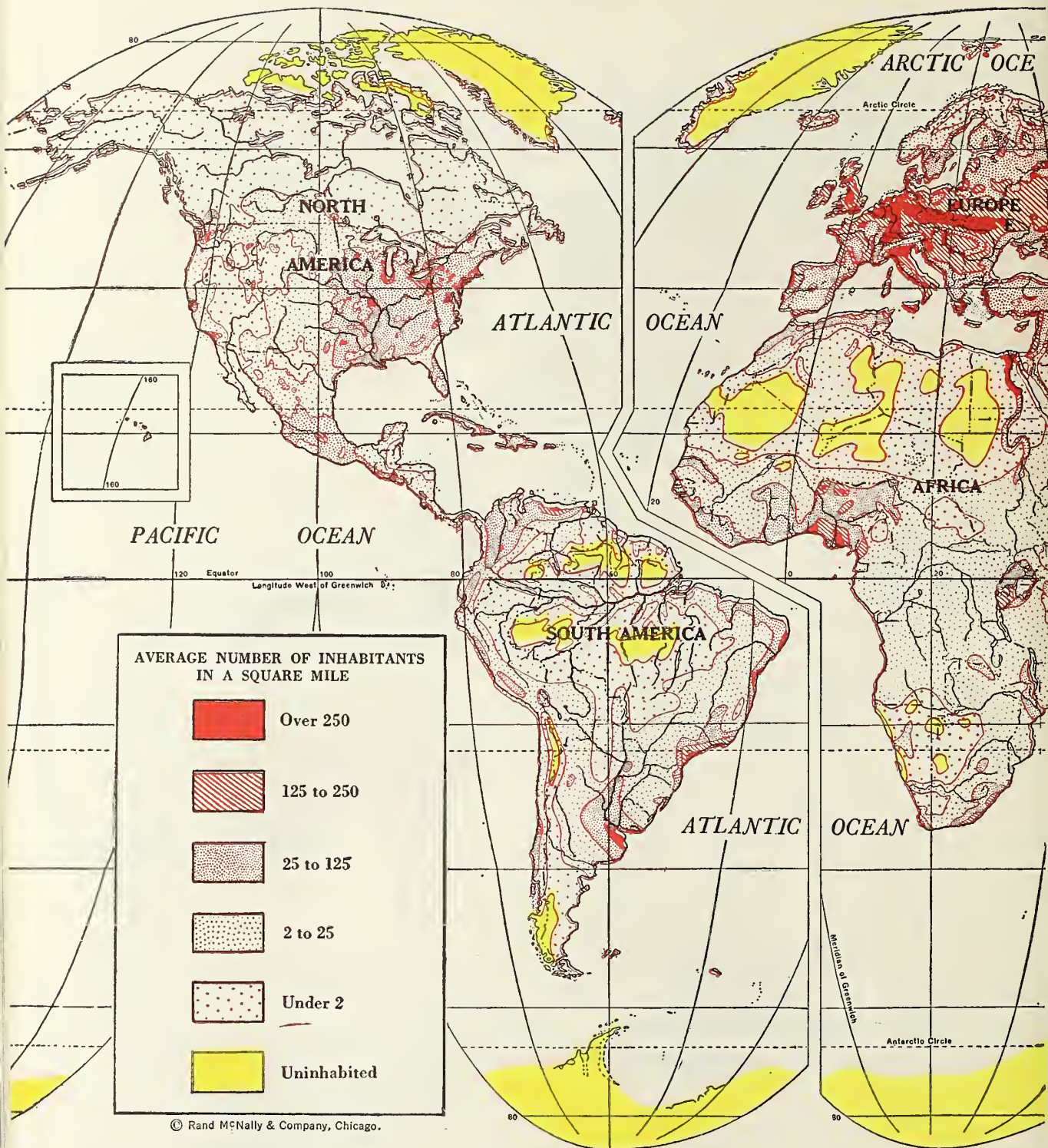


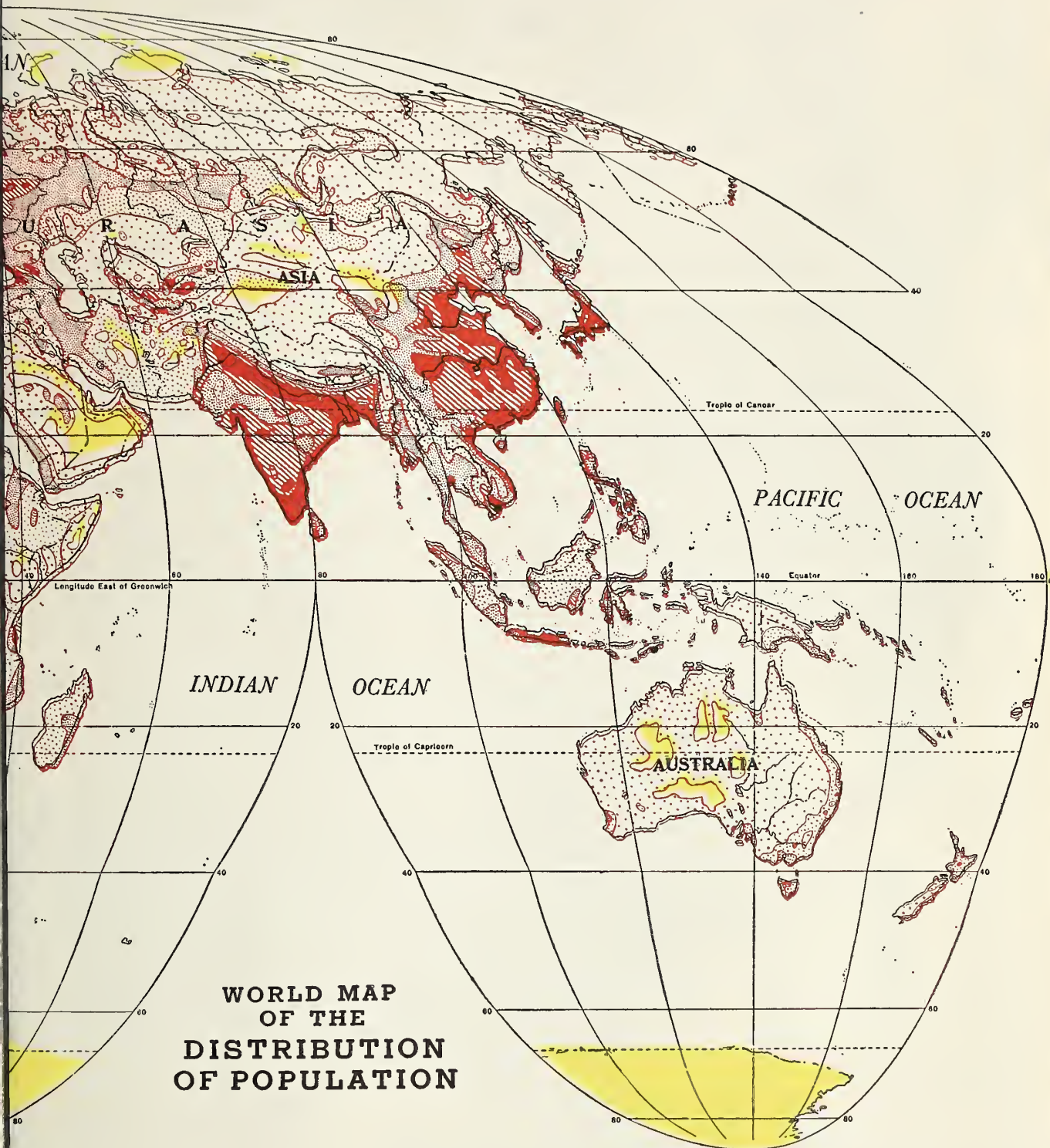
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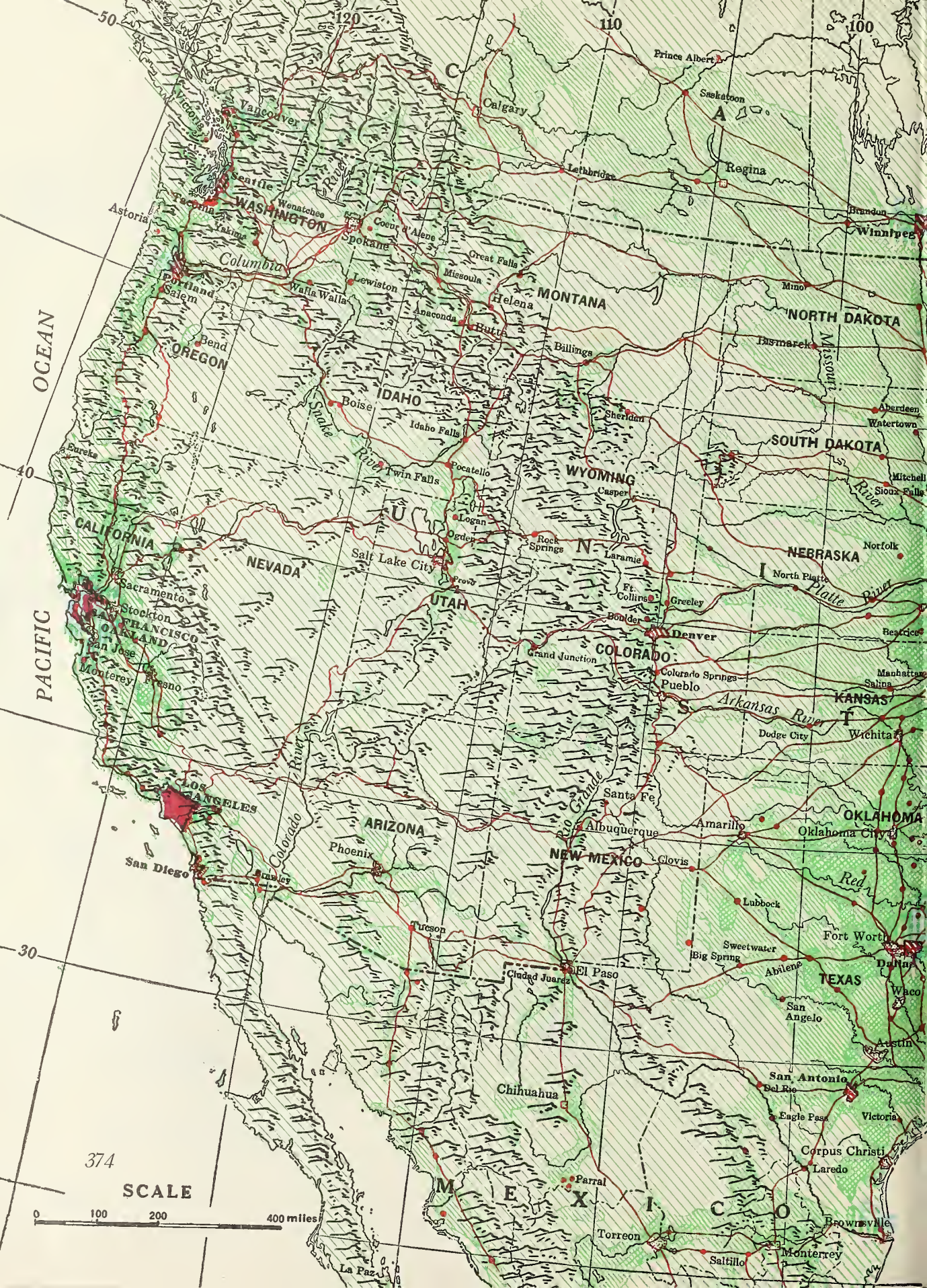
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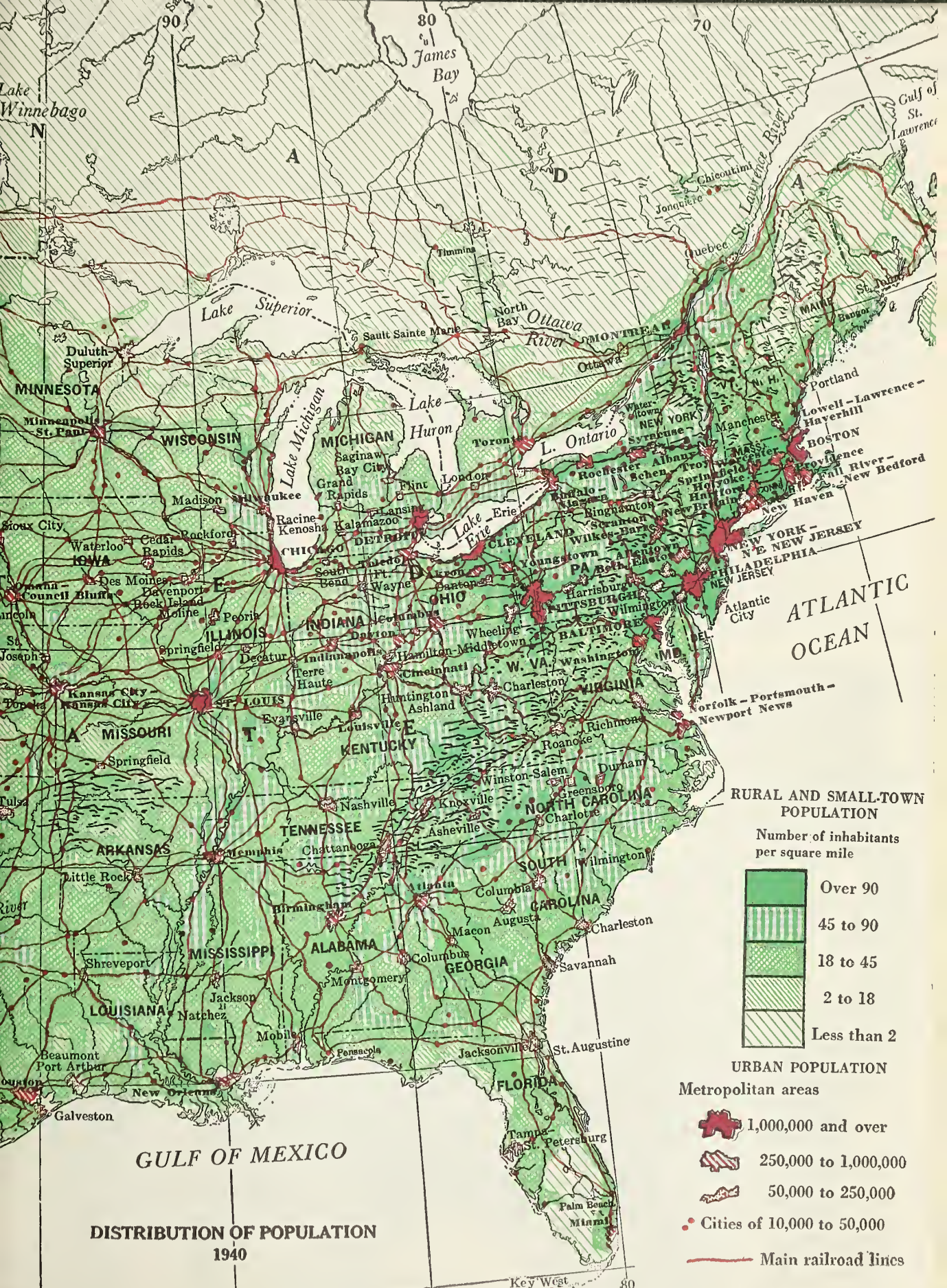




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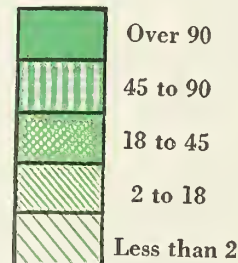
GULF OF MEXICO

DISTRIBUTION OF POPULATION

1940

RURAL AND SMALL-TOWN POPULATION

Number of inhabitants per square mile



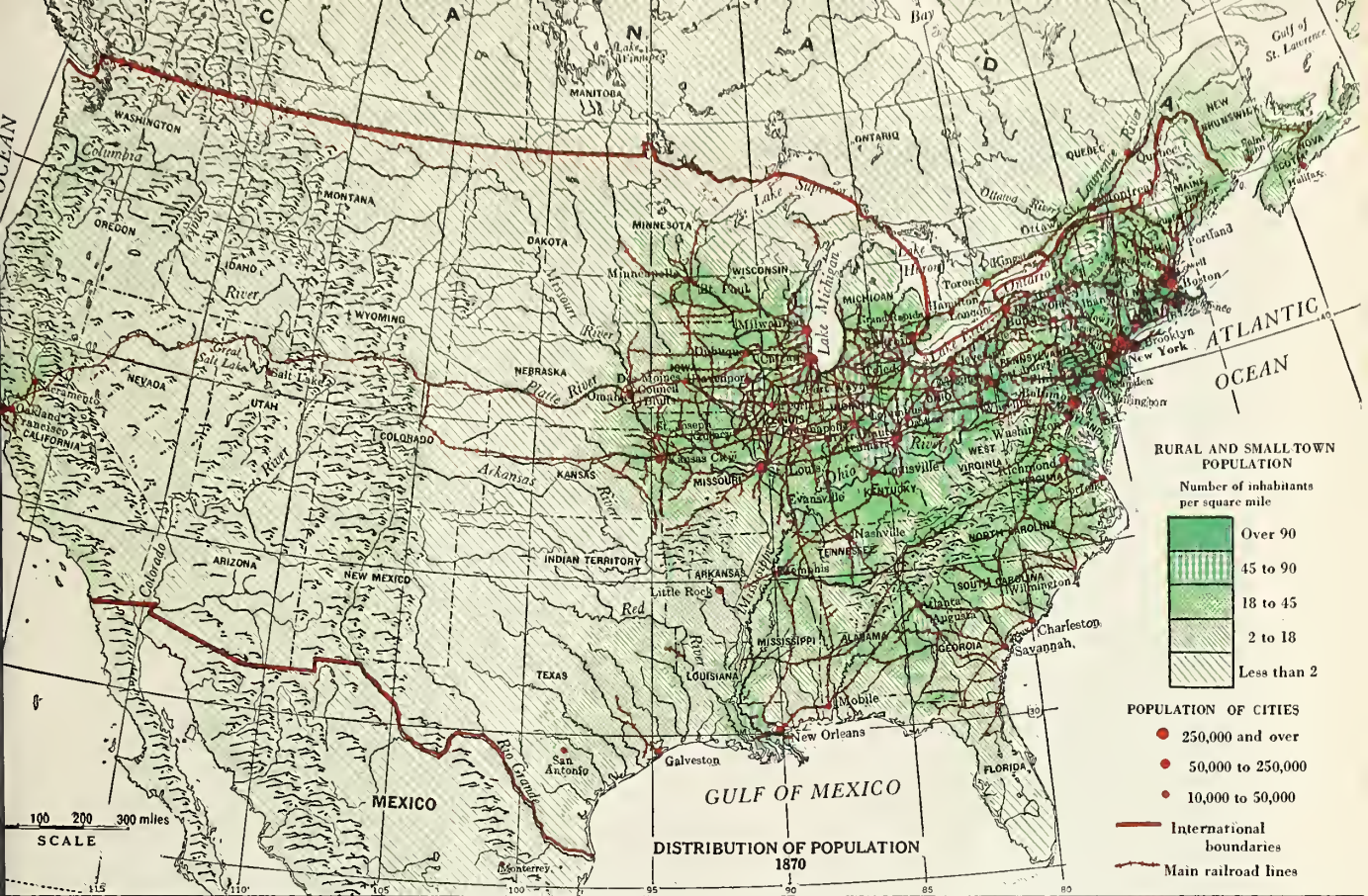
URBAN POPULATION

Metropolitan areas

- 1,000,000 and over
- 250,000 to 1,000,000
- 50,000 to 250,000
- Cities of 10,000 to 50,000
- Main railroad lines

Key West

80





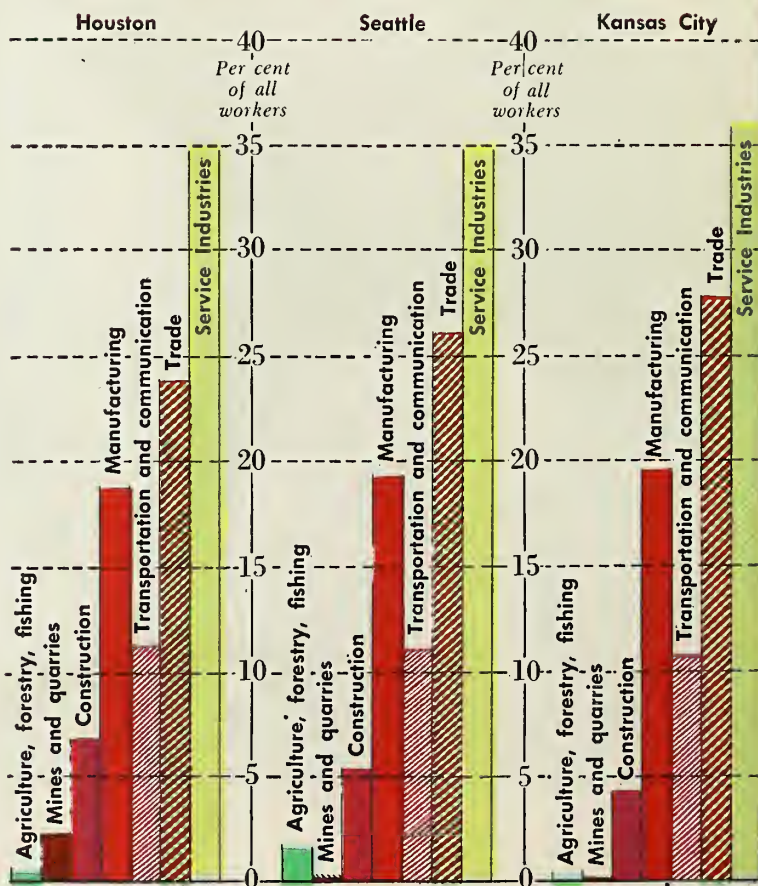
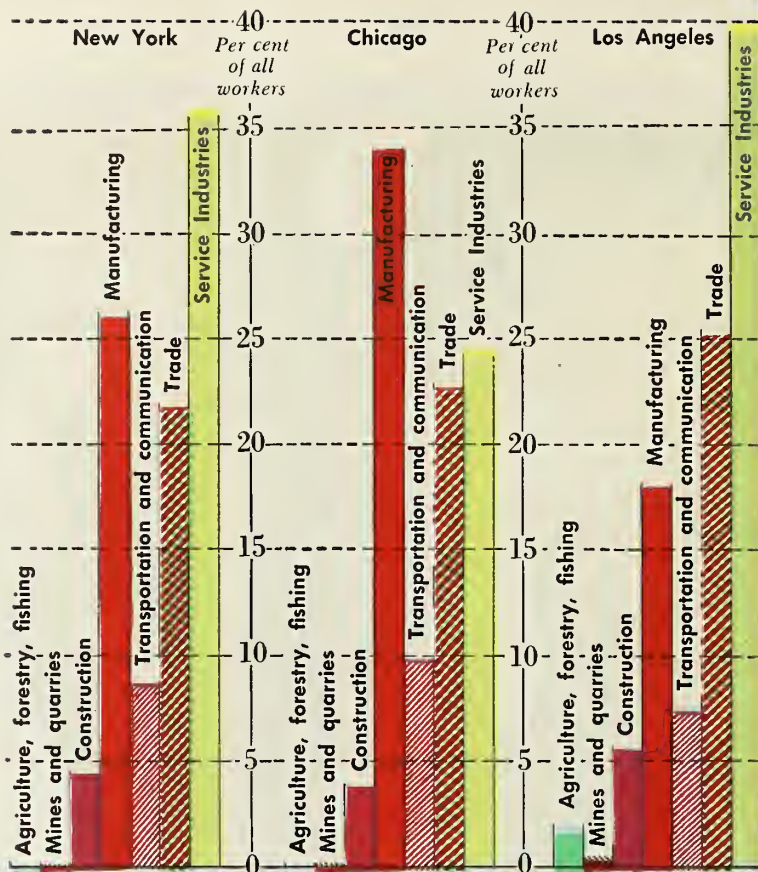
A physical-political map of the United States.

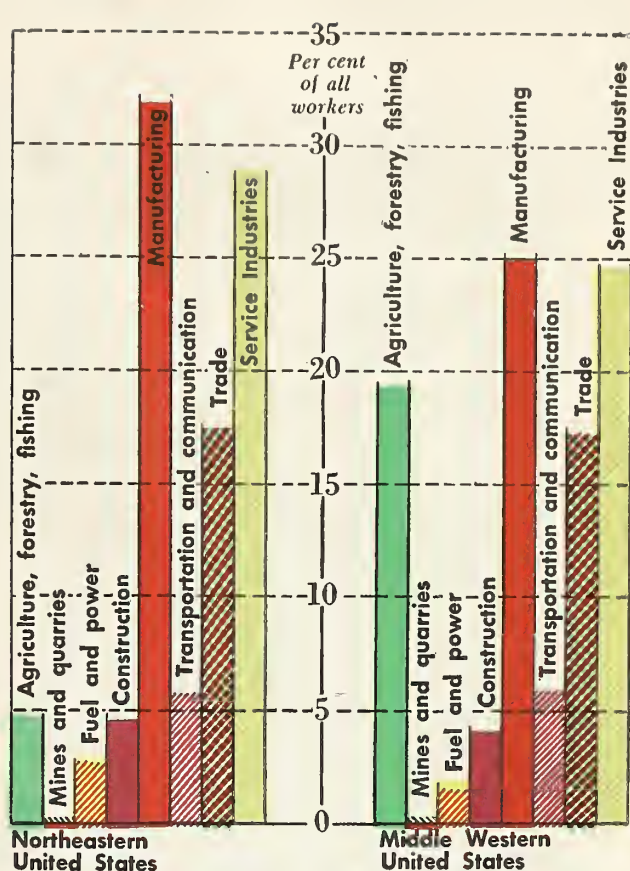
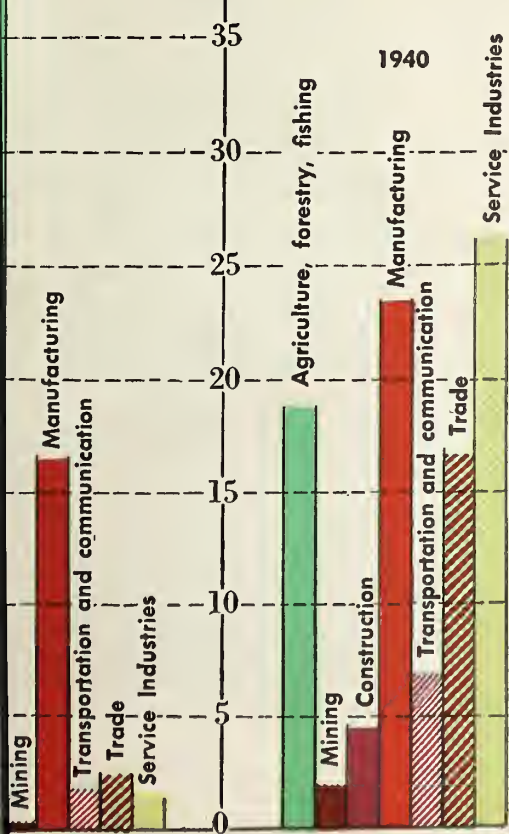
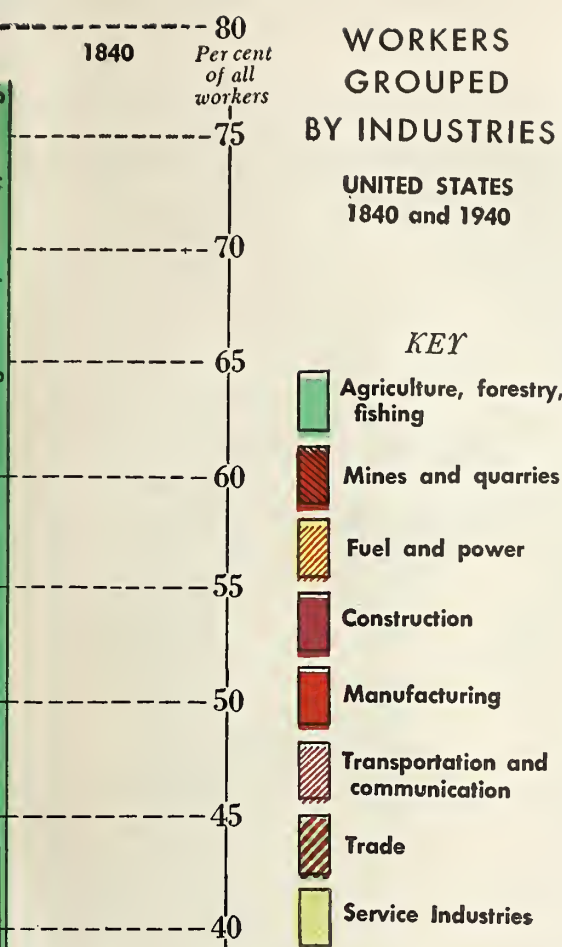


WORKERS GROUPED BY INDUSTRIES

1940

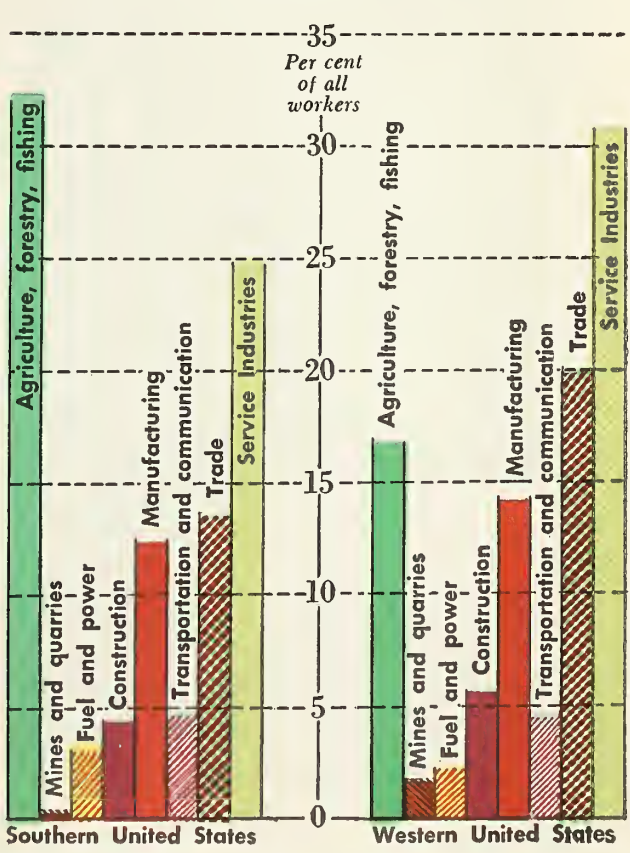
DETROIT
WASHINGTON, D. C.
NEW YORK
CHICAGO
LOS ANGELES
HOUSTON
SEATTLE
KANSAS CITY





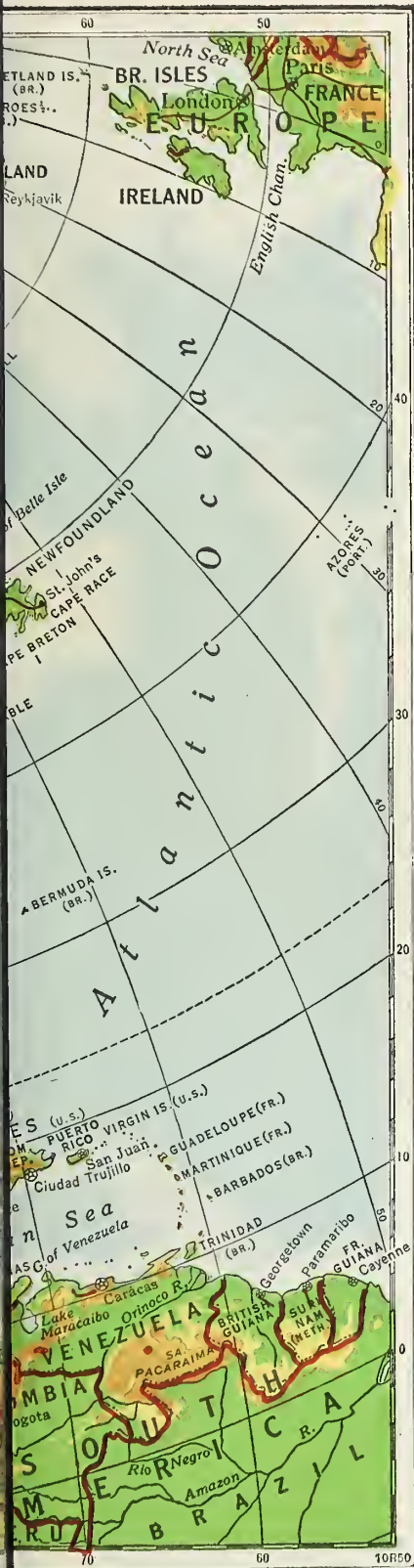
WORKERS GROUPED BY INDUSTRIES

1940





A physical-political map of North America.



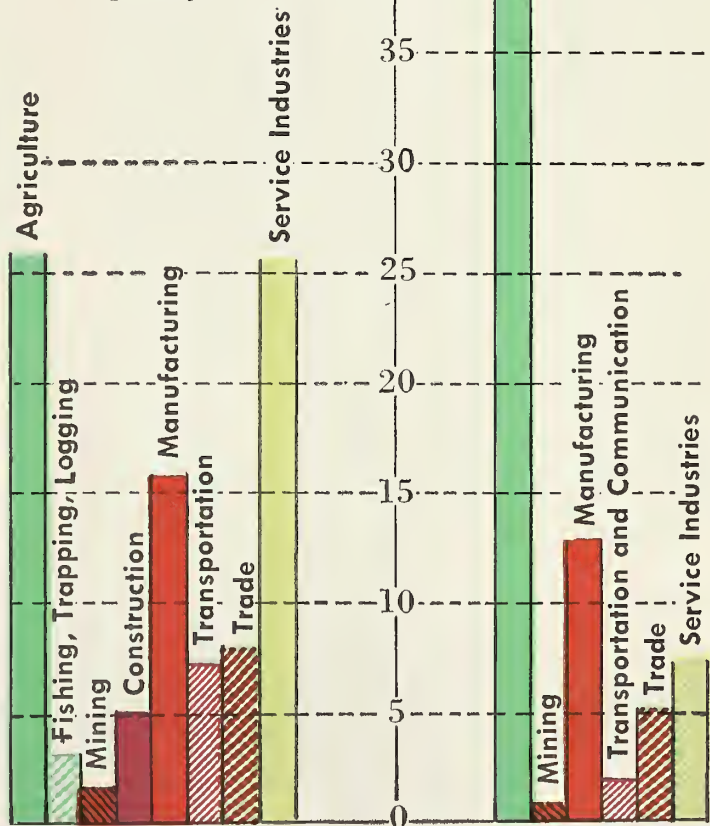
WORKERS GROUPED BY INDUSTRIES

75
Per cent
of all
workers

Mexico

Agriculture

Canada





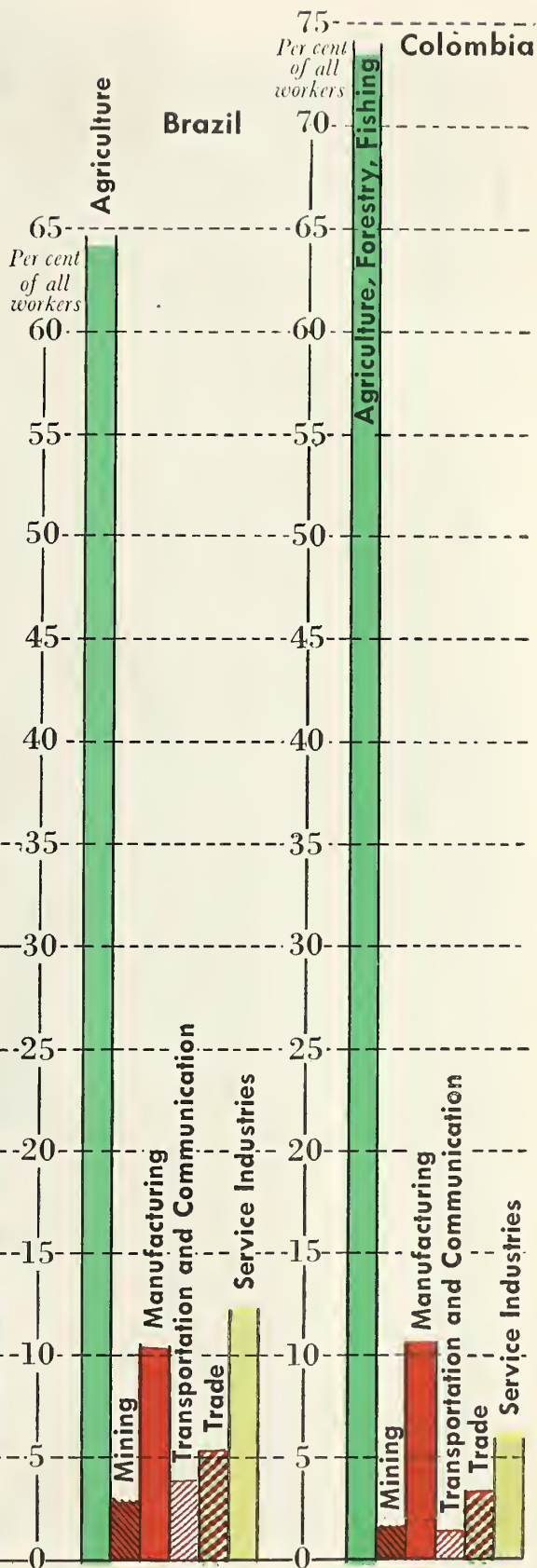
A physical-political map of South America.



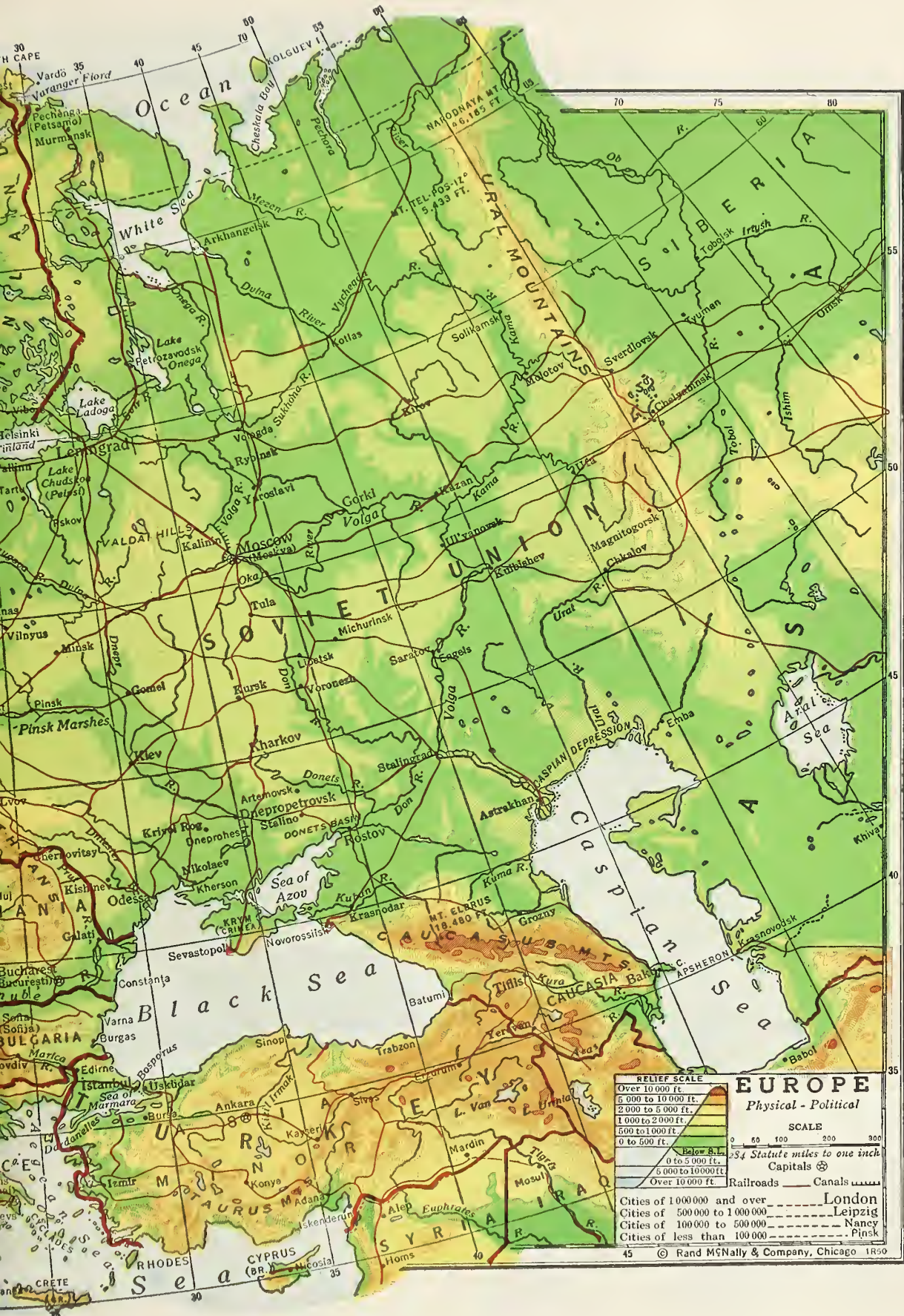
WORKERS GROUPED BY INDUSTRIES

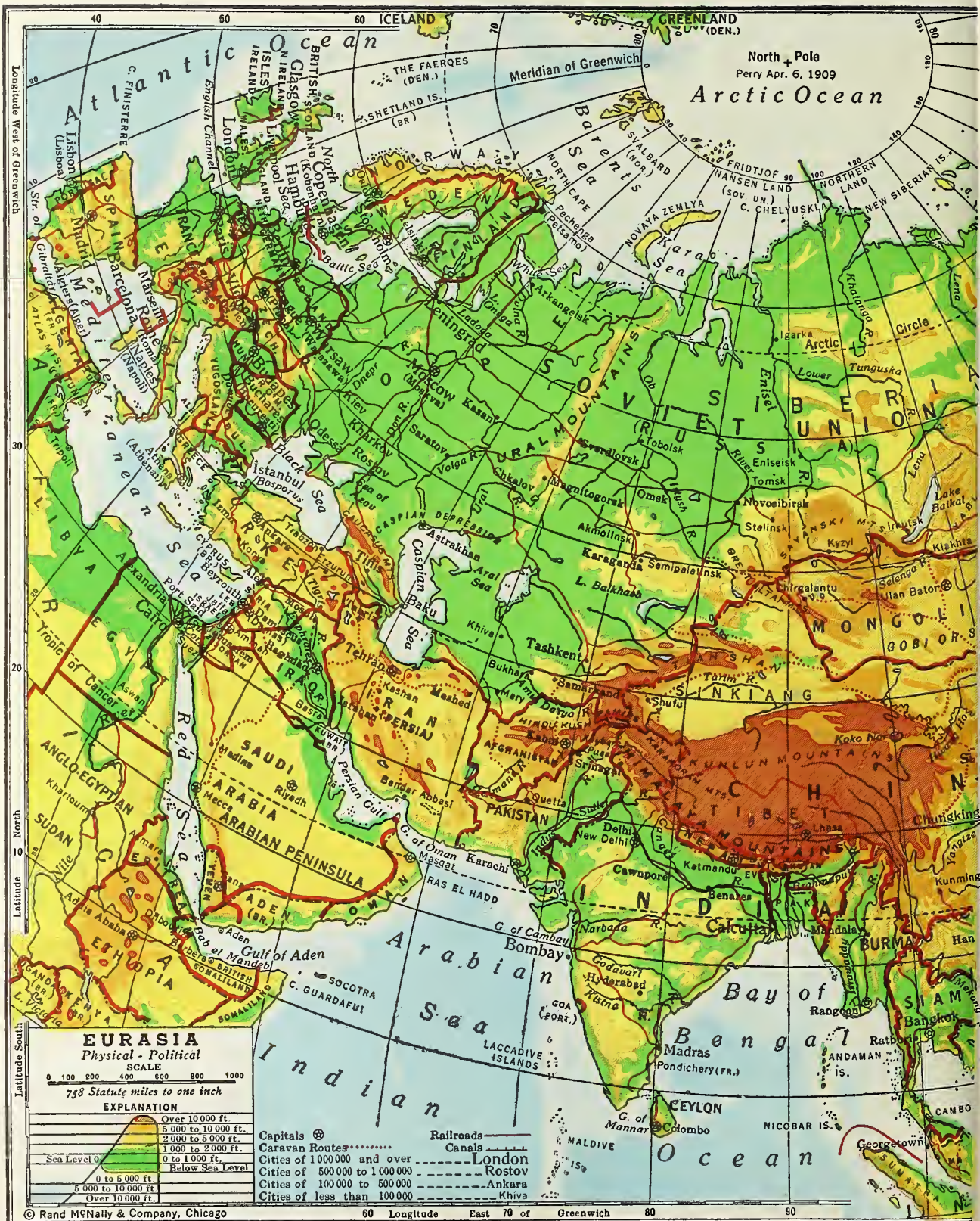
Agriculture, Fishing

Chile







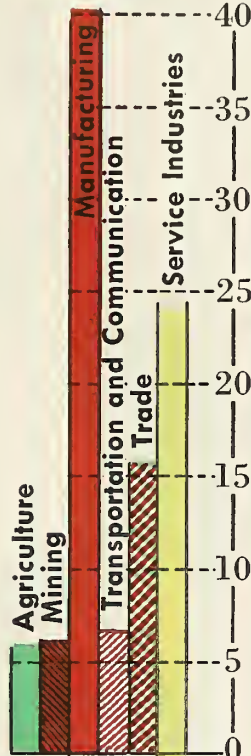


A physical-political map of Eurasia.



Great Britain

----- 45
Per cent
of all workers



WORKERS GROUPED BY INDUSTRIES

Romania

----- 80
Per cent
of all workers

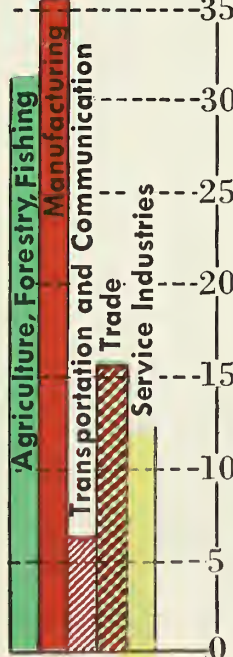


India



Denmark

----- 40
Per cent
of all workers





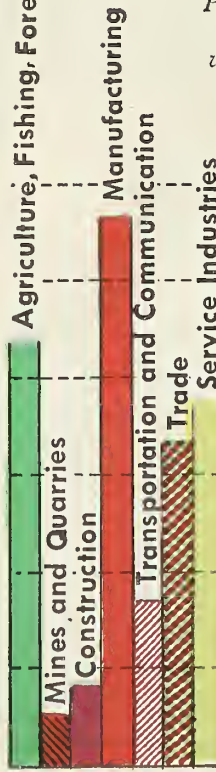
A physical-political map of Africa.



WORKERS GROUPED BY INDUSTRIES

Australia

Agriculture, Fishing, Forestry, Trapping

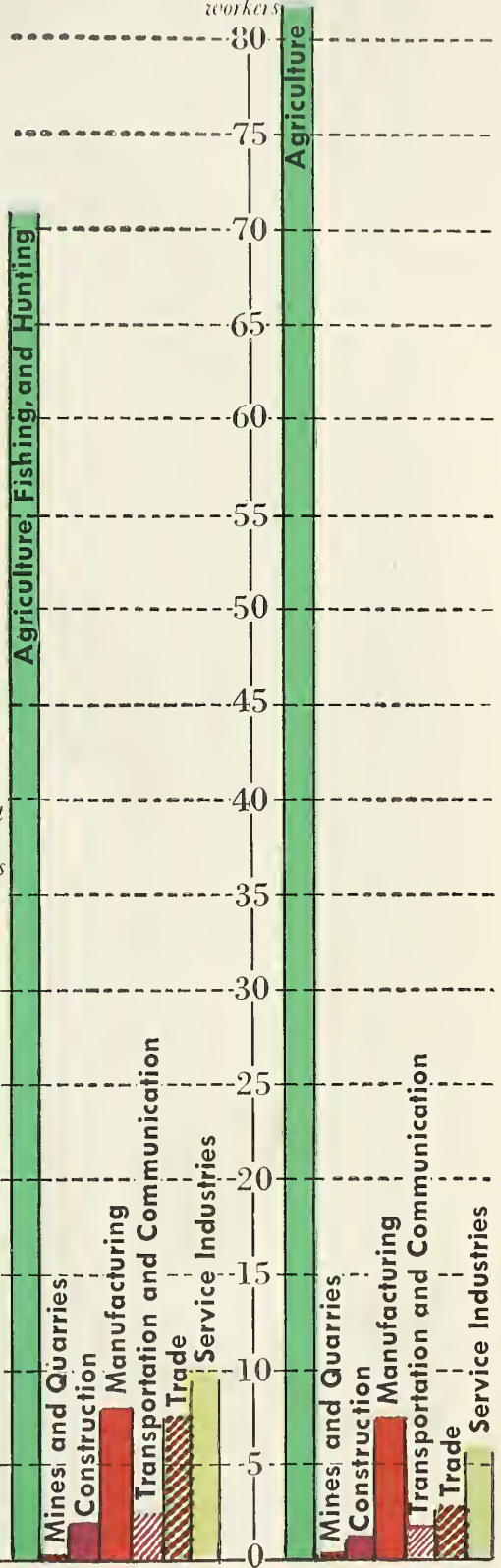


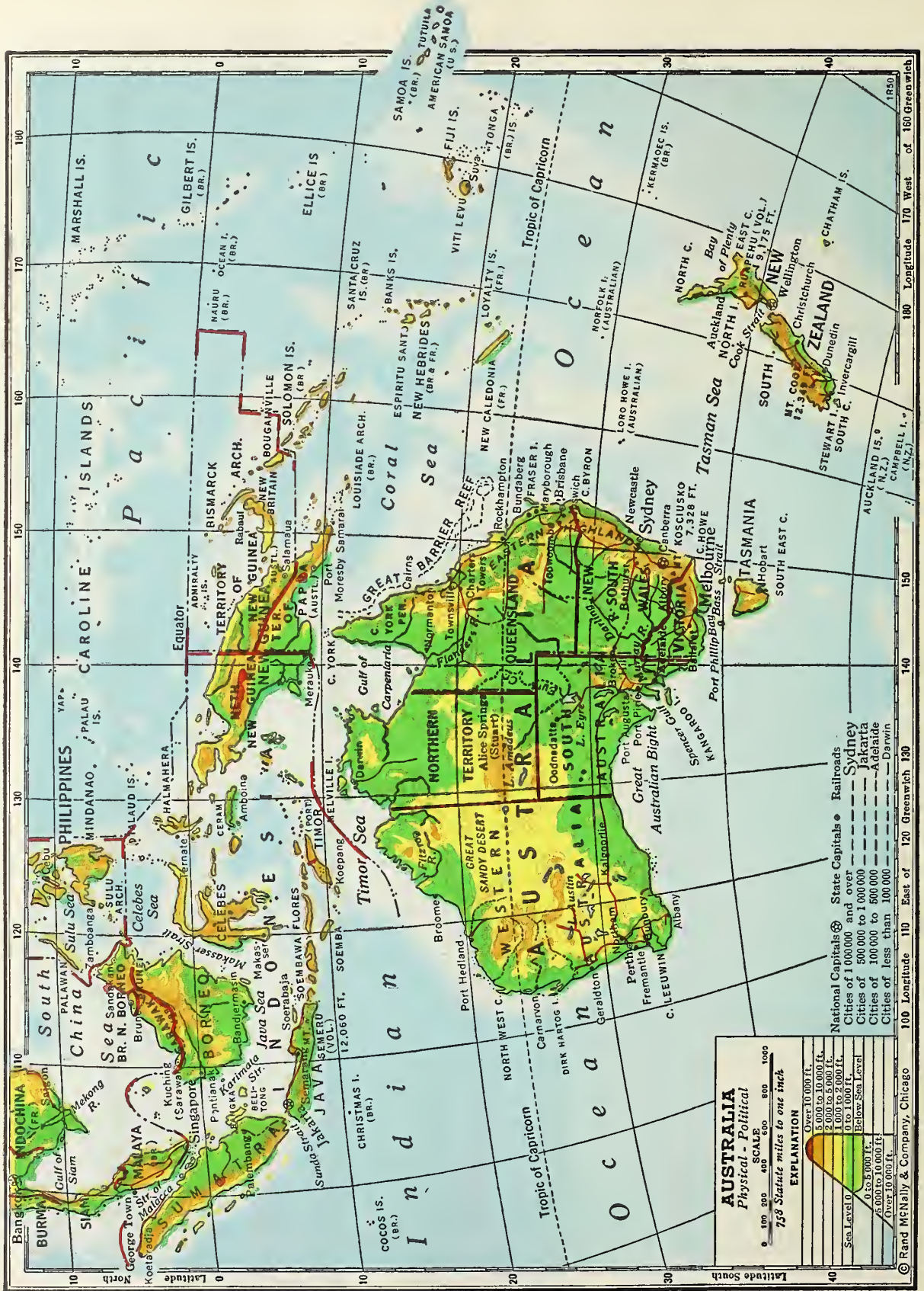
Per cent
of all
workers

Egypt

85
Per cent
of all
workers

Turkey





A physical-political map of Australia.

[illegible]

$\frac{2}{3} \times 6 = 4$

HF 1027 M12 1951 C-2
MCCONNELL WALLACE ROBERT 1881-
GEOGRAPHY OF A WORKING WORLD

39759483 HSS



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HF 1027 M12 1951 C. 2
McConnell, Wallace R.
Geography of a working world

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